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AVIATION
ORDNANCEMAN 1 & C

NAVAL TRAINING COMMAND

RATE TRAINING MANUAL NAVTRA 10347-C

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educational Services Officer.* The following courses are recommended:

D-166	Advanced Algebra
D-177	Geometry II
D-188	Trigonometry
E-291	Physics II
F-544	Personnel Management

* “Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more.”

CHAPTER 1

AVIATION ORDNANCEMAN RATING

This Rate Training Manual is designed to aid the AO2 in preparing for advancement to AO1 and the AO1 in preparing for advancement to AOC. It is based primarily on the professional requirements or qualifications for AO1 and AOC as specified in the Manual of Qualifications for Advancement, NavPers 18068 (Series). In preparing for advancement examinations, this manual should be studied in conjunction with the professionally related training manuals listed in the next paragraph and with Military Requirements for Petty Officer 1 & C, NavPers 10057 (Series). Any changes in the professional qualifications occurring after change O to NavPers 18068-C may not be reflected in the information presented in this Rate Training Manual.

This manual does not contain coverage on all "quals" listed in the "Quals" Manual. Some of the professional "quals" listed are wholly or partially covered by the following Rate Training Manuals:

Aviation Ordnanceman 3 & 2, NavPers 10345-C, Chapter 16.

Synchro, Servo and Gyro Fundamentals, NavPers 10105, Chapter 5.

Military Requirements for PO 1 & C, NavPers 10057-C, Chapter 10.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings: general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

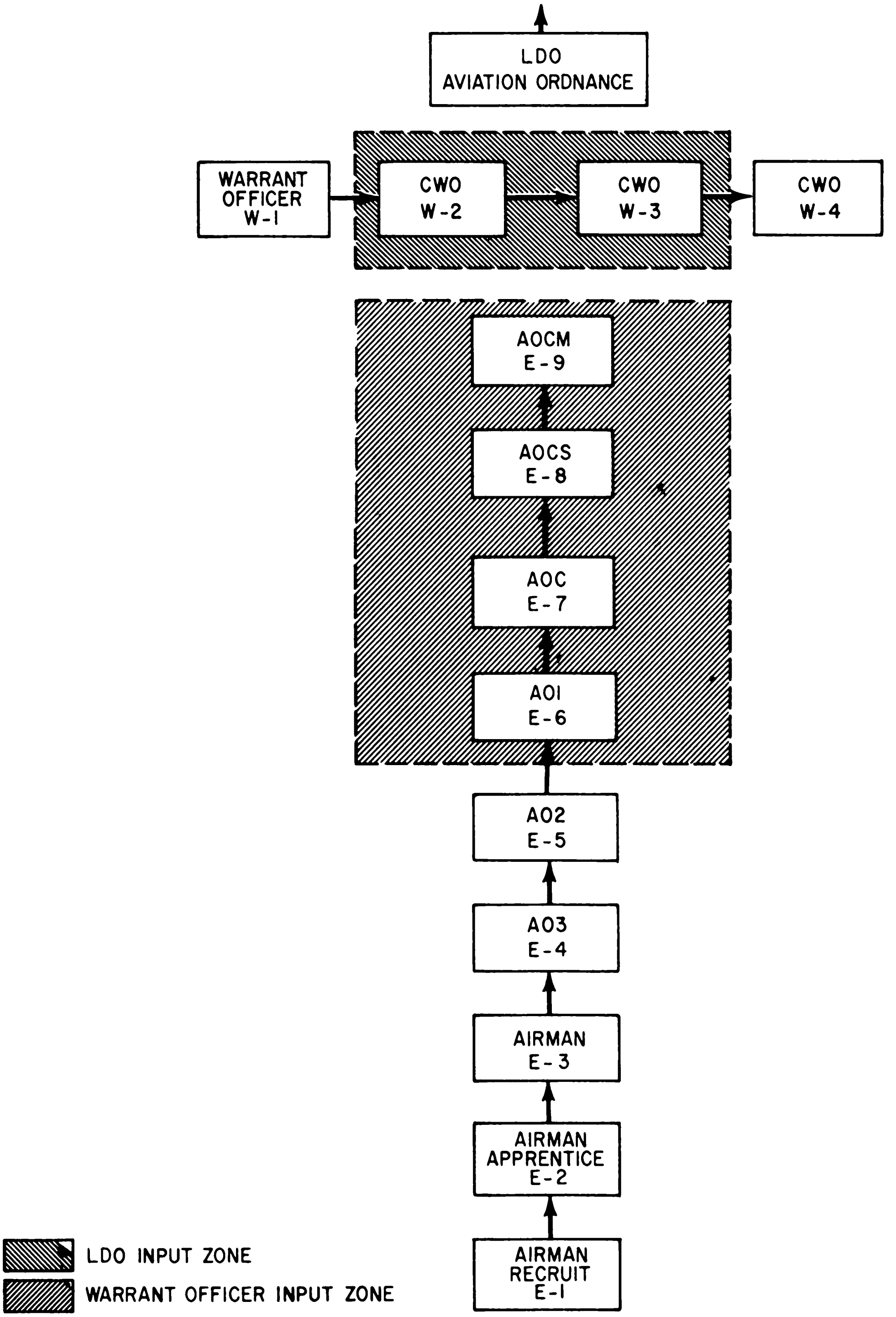
Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

AO RATING

The Aviation Ordnanceman rating is a general rating and is included in Navy Occupational Group IX (Aviation). There are no service ratings in this general rating.

The Aviation Ordnanceman rating maintains its identity throughout the rating. Figure 1-1 illustrates the paths of advancement from Airman Recruit to Master Chief Aviation Ordnanceman (AOCM), Chief Warrant Officer (W-4, or to Limited Duty Officer (LDO). The advancement path through the AO rating is emphasized in the figure. Shaded areas indicate career stages where qualified enlisted men may advance to Warrant Officer (W-1), and selected Warrant Officers may advance to Limited Duty Officer. Personnel in enlisted rates and warrant ranks may advance only as indicated by the lines.

The Manual of Qualifications for Advancement, NavPers 18068 (Series), establishes the AO's responsibility for the maintenance and inspection of aircraft weapons systems and equipment.



AO.1

Figure 1-1.—Paths of advancement.

When advanced to AO1 or AOC, even more responsibilities are to be yours. As a senior petty officer, you must possess more than technical knowledge. You must assume greater responsibility not only for your own work, but also for the work of others who serve under you. The AO1 and AOC must be a supervisor, inspector, and instructor, as well as an accomplished military leader. Senior petty officers should therefore be vitally concerned with the Naval Leadership Program.

As a result of the Naval Leadership Program, a considerable amount of material related to naval leadership for the senior petty officer is available. Studying this material will make you aware of your many leadership responsibilities as a senior petty officer and will also be of great help in developing leadership qualities. It will not in itself, however, make you a good leader. Leadership principles can be taught, but a good leader acquires that quality only through hard work and practice.

As you study this material containing leadership traits, keep in mind that probably none of our most successful leaders possessed all of these traits to a maximum degree, but a weakness in some traits was more than compensated for by strength in others. Critical self-evaluation will enable you to realize the traits in which you are strong and to capitalize on them. At the same time you must strive to improve on the traits in which you are weak.

Your success as a leader will be decided, for the most part, by your achievements in inspiring others to learn and perform. This is best accomplished by personal example.

BILLETS AVAILABLE

A wide variety of assignments is available to the AO1 and AOC. In addition to the various types of maintenance activities to which lower rated personnel are assigned (discussed in AO 3 & 2, NavPers 10345-C), the AO1 and AOC are eligible for assignment to instructor duty as well as a number of other desirable shore billets. Most of these billets are under the management control of BuPers and are directly associated with training. Others are associated with research, testing, or evaluation. Some of the more desirable billets to which the AO1 and AOC may be assigned are described in the following paragraphs.

Instructor duty is available to both the AO1 and the AOC at the Naval Air Technical Training Center, Jacksonville, Florida, in the following courses:

1. Aviation Ordnanceman Course (Class A).
2. Aviation Ordnanceman Course (Class B).

In addition to the above listed instructor billets, the AO1 and AOC may be assigned to instructor duty with a Naval Air Maintenance Training Detachment (NAMTD). NAMTD's are located at shore stations on both coasts. Personnel assigned to this duty are first sent to Naval Air Maintenance Training Group headquarters at Memphis, Tennessee, for a period of indoctrination and instruction.

Instructor billets are normally filled on a voluntary basis. Detailed information concerning assignment to instructor duty is contained in the Enlisted Transfer Manual, NavPers 15909 (Series).

Senior Chief Aviation Ordnancemen are eligible for assignment to duty with the Navy Training Publications Center (NTPC), NAS Memphis, as Technical Writers. They assist in the preparation and revision of Rate Training Manuals for the Group IX (Aviation) ratings. AO's assigned to these billets assist in preparing and/or revising Rate Training Manuals for the ordnance ratings.

Senior Chief Aviation Ordnancemen are also eligible for assignment to duty with the Naval Examining Center, Great Lakes, Illinois, as Item Writers. CPO's assigned to the Examining Center assist in the preparation of Navy-wide advancement-in-rating examinations for enlisted personnel. AO's assigned to these billets assist in preparing examinations for the AO ratings.

There are a number of special programs and projects to which enlisted personnel may be assigned. For a listing of these special programs and projects, reference should be made to the Enlisted Transfer Manual. Others are also announced from time to time in BuPers Notices.

Personnel may indicate their desire for assignment to a specific program or project by indicating it in the "remarks" block of their Rotation Data Card.

As a petty officer, you are already aware of the importance of the AO rating to naval aviation. Pilots and aircrewmen depend upon the AO for the efficient operation of the weapons systems for which he is responsible. As improved weapons systems are developed, the AO's job involves new and greater responsibilities; from the lowest level up, he must possess greater technical skills than ever before.

ADVANCEMENT

By this time, you are probably well aware of the personal advantages of advancement—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a technical specialist, and thus make far-reaching contributions to the entire Navy; and second, you become more valuable as a person who can supervise, lead, and train others.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement. However, you may find it helpful to read the following sections. The Navy does not stand still. It is possible that some of the requirements have changed since the last time you went up for advancement. Furthermore, you will be responsible for training others for advancement; therefore, you will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement, a person must:

1. Have a certain amount of time in grade.
2. Complete the required Rate Training Manuals either by demonstrating a knowledge of the material in the manual by passing a locally prepared and administered test or by passing the Enlisted Correspondence Course based on the Rate Training Manual.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavPers 1414/1.
4. Be recommended by his commanding officer, after the petty officers and officers supervising the work have indicated that they consider him capable of performing the duties of the next higher rate.
5. Demonstrate KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives an overall view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement, but it does not guarantee his advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and quotas for the rating enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? You must study the qualifications for advancement, work on the practical factors, study the required Rate Training Manuals, and study other material that is required. You will need to be familiar with the following:

1. Manual of Qualifications for Advancement, NavPers 18068 (Series).
2. Record of Practical Factors, NavPers 1414/1.
3. Bibliography for Advancement Study, NavTra 10052 (Series).
4. Applicable Rate Training Manuals and their companion Enlisted Correspondence Courses.

Collectively, these documents make up an integrated training package tied together by the qualifications. The following paragraphs describe these materials and give some information on how each one is related to the others.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement to each

REQUIREMENTS*	E1 to E2	E2 to E3	#† E3 to E4	#E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of	8 mos. as E-2.	6 mos. as E-3	12 mos. as E-4	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training (C.O. may advance up to 10% of graduating class.)		Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3.			Class B for AGC MUC, MNC.††		
PRACTICAL FACTORS	Locally prepared check-offs.	Record of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5, and E-6: 2 years for E-7, E-8, and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.
†† Waived for qualified EOD personnel.

Figure 1-2.—Active duty advancement requirements.

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	8 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 8 yrs service	36 mos. with total 11 yrs service	24 mos. with total 13 yrs service
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO advancements. Also pass Military Leadership Exam for E-4 and E-5.				Standard Exam, Selection Board.	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

*Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

rate within each rating. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all ratings rather than to any one rating alone. Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Rate Training Manuals are revised. By the time you are studying this training manual, the "quals" for your rating may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.
2. Each "qual" has a designated rate level—chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels. This manual is written to provide additional or add-on information to that contained in AO3 & 2, NavPers 10345-C, and it is recommended that the material in this 3 & 2 manual be reviewed.
3. The written examinations for advancement will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

Record of Practical Factors

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 1414/1 (plus the abbreviation of the appropriate rating), is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rating, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually inserted in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

The importance of NavPers 1414/1 cannot be overemphasized. It serves as a record to indicate to the petty officers and officers supervising your work that you have demonstrated proficiency in the performance of the indicated practical factors and is part of the criteria utilized by your commanding officer when he considers recommending you for advancement. In addition, the proficient demonstration of the applicable practical factors listed on this form can aid you in preparing for the examination for advancement. Remember that the knowledge aspects of the practical factors are covered in the examination for advancement. Certain knowledge is required to demonstrate these practical factors and additional knowledge can be acquired during the demonstration. Knowledge factors pertain to that knowledge which is required to perform a certain job. In other words, the knowledge factors required for a certain rating depend upon the jobs (practical factors) that must be performed by personnel of that rating. Therefore, the knowledge required to proficiently demonstrate these practical factors will definitely aid you in preparing for the examination for advancement.

NavTra 10052

Bibliography for Advancement Study, NavTra 10052 (Series) is a very important publication for anyone preparing for advancement. This publication/bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavTra 10052 (Series) is revised and issued once each year by the Naval Training Command. Each revised edition is identified by a letter following the NavTra number; be SURE you have the most recent edition.

The required and recommended references are listed by rate level in NavTra 10052 (Series). It is important to remember that you are responsible for all references at lower rate levels, as well as those listed for the rate to which you are seeking advancement.

Rate Training Manuals that are marked with an asterisk (*) in NavTra 10052 (Series) are MANDATORY at the indicated rate levels. A mandatory training manual may be completed by (1) passing the appropriate Enlisted Correspondence Course that is based on the mandatory training manual; (2) passing locally prepared tests based on the information given in the mandatory training manual; or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement, do not overlook the section of NavTra 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance. Also, make sure that personnel working for advancement study the references listed as recommended but not mandatory in NavTra 10052 (Series). It is important to remember that ALL references listed in NavTra 10052 (Series) are used as primary source material for the written examinations, at the appropriate levels. In addition, any reference made in the primary source material to other material (instructions, manuals, etc.) may be used as secondary source material for the written examination.

Rate Training Manuals

There are two general types of Rate Training Manuals. Rate Training Manuals (such as this one) are prepared for most enlisted rates and ratings, giving information that is directly related to the professional qualifications for advancement. Subject matter manuals give information that applies to more than one rating.

Rate Training Manuals are revised from time to time to bring them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether a Rate Training Manual is the latest edition by checking the NavPers number (and the letter following the number) in the most recent edition of List of Training Manuals and Correspondence Courses, NavTra 10061 (Series). (NavTra 10061 is actually a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed for the special purpose of helping naval personnel prepare for advancement. By this time, you have probably developed your own way of studying these manuals. Some of the personnel you train, however, may need guidance in the use of Rate Training Manuals. Although there is no single "best" way to study a training manual, the following suggestions have proved useful for many people:

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual primarily to meet these "quals."

2. Set up a regular study plan. If possible, schedule your studying for a time of day when

you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, get acquainted with the entire manual. Read the preface and the table of contents. Check through the index. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual.

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Or is this something new and different? How does this information relate to the qualifications for advancement?

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas you have learned from studying this unit. Do not just quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing an Enlisted Correspondence Course based on the training manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training manuals. Taking a correspondence course helps you to master the information given in the training manual, and also gives you an idea of how much you have learned.

10. You should remember that occasionally reference is made in the Rate Training Manual and other primary source material to publications which contain information relative to the rating, but which are not listed in NavTra 10052 (Series). These are known as secondary references and should be reviewed in conjunction with your study of the Rate Training Manual to better prepare yourself for advancement.

INCREASED RESPONSIBILITIES

When you assumed the duties of a PO3, you began to accept a certain amount of responsibility for the work of others. With each advancement, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rate. When you advance to PO1 or CPO, you will find a noticeable increase in your responsibilities for leadership, supervision, training, working with others, and keeping up with new developments.

As your responsibilities increase, your ability to communicate clearly and effectively must also increase. The simplest and most direct means of communication is a common language. The basic requirement for effective communication is therefore a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communication is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

Leadership and Supervision

As a PO1 or CPO, you will be regarded as a leader and supervisor. Both officers and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical, on-the-job language that can be understood and followed by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their jobs correctly. At the same time, you must be able to explain to officers any important problems or needs of enlisted personnel. In all military and professional matters, your responsibilities will extend both upward and downward.

Along with your increased responsibilities, you will also have increased authority. Officers and petty officers have POSITIONAL authority—that is, their authority over others lies in their positions. If your CO is relieved, for example, he no longer has the degree of authority over you that he had while he was your CO, although he still retains the military authority that all seniors have over subordinates. As a PO1, you will have some degree of positional authority; as a CPO, you will have even more. When exercising your authority, remember that it is positional—it is the rate you have, rather than the person you are, that gives you this authority.

A Petty Officer conscientiously and proudly exercises his authority to carry out the responsibilities he is given. He takes a personal interest in the success of both sides of the chain of command . . . authority and responsibility. For it is true that the Petty Officer who does not seek out and accept responsibility, loses his authority and then the responsibility he thinks he deserves. He must be sure, by his example and by his instruction, that the Petty Officers under him also accept responsibility. In short, he must be the leader his title—Petty Officer—says he is.

Training

As a PO1 or CPO, you will have regular and continuing responsibilities for training others. Even if you are lucky enough to have a group of subordinates who are all highly skilled and well trained, you will still find that training is necessary. For example, you will always be responsible for training lower rated personnel for advancement. Also, some of your best workers may be transferred; and inexperienced or poorly trained personnel may be assigned to you. A particular job may call for skills that none of your personnel have. These and similar problems require that you be a training specialist—one who can conduct formal and informal training programs to qualify personnel for advancement, and one who can train individuals and groups in the effective execution of assigned tasks.

In using this training manual, study the information from two points of view. First, what do you yourself need to learn from it? And second, how would you go about teaching this information to others?

Training goes on all the time. Every time a person does a particular piece of work, some learning is taking place. As a supervisor and as a training expert, one of your biggest jobs is to see that your personnel learn the RIGHT things about each job so that they will not form bad work habits. An error that is repeated a few times is well on its way to becoming a bad habit. You will have to learn the difference between oversupervising and not supervising enough. No one can do his best work with a supervisor constantly supervising. On the other hand, you cannot turn an entire job over to an inexperienced person and expect him to do it correctly without any help or supervision.

In training lower rated personnel, emphasize the importance of learning and using correct terminology. A command of the technical languages of your occupational field (rating) enables you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with the work of his rating is definitely at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the examinations for advancement. To train others in the correct use of technical terms, you will need to be very careful in your own use of words. Use correct terminology and insist that personnel you are supervising use it too.

You will find the Record of Practical Factors, NavPers 1414/1, a useful guide in planning and carrying out training programs. From this record, you can tell which practical factors have been checked off and which ones have not yet been done. Use this information to plan a training program that will fit the needs of the personnel you are training.

On-the-job training is usually controlled through daily and weekly work assignments. When you are working on a tight schedule, you will generally want to assign each person to the part of the job that you know he can do best. In the long run, however, you will gain more by assigning personnel to a variety of jobs so that each person can acquire broad experience. By giving people a chance to do carefully supervised work in areas in which they are relatively inexperienced, you will increase the range of skills of each person and thus improve the flexibility of your working group.

Working With Others

As you advance to PO1 or CPO, you will find that many of your plans and decisions affect a large number of people, some of whom are not even in your own occupational field (rating). It becomes increasingly important, therefore, for you to understand the duties and the responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of others, and plan your own work so that it will fit into the overall mission of the organization.

Keeping Up With New Developments

Practically everything in the Navy—policies, procedures, publications, equipment, systems—is subject to change and development. As a PO1 or CPO, you must keep yourself informed about changes and new developments that affect you or your work in any way.

Some changes will be called directly to your attention, but others will be harder to find. Try to develop a special kind of alertness for new information. When you hear about anything new in the Navy, find out whether there is any way in which it might affect the work of your rating. If so, find out more about it.

SOURCES OF INFORMATION

As a PO1 or CPO, you must have an extensive knowledge of the references to consult for accurate, authoritative, up-to-date information on all subjects related to the military and professional requirements for advancement.

Publications mentioned in this chapter are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made.

The reading list at the beginning of this manual consists of USAFI courses that offer additional background material. The educational services officer will always have the most up-to-date information and training manuals applicable to your rating.

In addition to training manuals and publications, training films furnish a valuable source of supplementary information. Films that may be helpful are listed in the U. S. Navy Film Catalog, NavAir 10-1-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief petty officer is not the end of the line as far as advancement is concerned. Proficiency pay, advancement to Senior (E-8) and Master (E-9) Chief, and advancement to Warrant Officer and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The Career Compensation Act of 1949, as amended, provides for the award of Proficiency Pay to designated military specialities. Proficiency Pay is given in addition to regular pay and allowances and any special or incentive pay to which you are entitled. Certain enlisted personnel in pay grades E-4 through E-9 are eligible for Proficiency Pay. Proficiency Pay is awarded in two categories: (1) Shortage Speciality Pay—to designated ratings and NEC's, and (2) Special Duty Assignment Pay—for duty in certain critical special duty assignments not covered by Shortage Specialty Pay. The eligibility requirements for Proficiency Pay are subject to change. In general, however, you must be recommended by your commanding officer, have a certain length of time on continuous active duty, and be career designated.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief Petty Officers may qualify for the advanced grades of Senior and Master Chief Petty Officer which are now provided in the enlisted pay structure. These advanced grades provide for substantial increases in pay, together with increased responsibilities and additional prestige. The requirements for advancement to Senior and Master Chief Petty Officer are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, a sufficiently high mark on the Navy-wide examination, and an interview with a local interview board. The final selection for Senior and Master Chief Petty Officer is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Chief Petty Officers.

Bibliography for Advancement Study, NavTra 10052 (Series) contains a list of study references which may be used to study for both military and professional requirements.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program provides opportunity for advancement to warrant rank for E-6 and above enlisted personnel. E-6's, to be eligible, must have passed an E-7 rating exam prior to selection.

The LDO program provides a path of advancement from warrant officer to commissioned officer. LDO's are limited, as are warrants, in their duty, to the broad technical fields associated with their former rating.

If interested in becoming a warrant or commissioned officer, ask your educational services officer for the latest requirements that apply to your particular case.

CHAPTER 2

MANAGEMENT

The AO in a supervisory position sets in motion the plans, schedules, and policies of his superiors. His primary concern is seeing that the job gets done, rather than performing the work himself.

To accomplish this end, the supervisor must know his men, assign them work within their capabilities, direct their efforts, and assume responsibility for seeing that each job is done correctly.

The supervisor's objectives are to operate with maximum efficiency and safety, to operate with minimum expense and waste, and to operate as much as possible free from interruption and difficulty. These three objectives are amplified in Military Requirements for Petty Officer 1 & C, NavPers 10057 (Series).

It is important that an AO assigned supervisory duties keep in mind the importance of his new assignment to him personally. It affords him the opportunity to gain practical experience for future promotions. His duties cannot be approached in a haphazard manner. To make right decisions, the supervisor must be knowledgeable, possess integrity, and utilize common sense. He should employ the principles of good leadership in carrying out his assignment. The information provided in Principles and Problems of Naval Leadership, NavPers 15924 (Series), will prove invaluable to the new supervisor until he has gained more experience.

Effective supervision of a work center requires a competent degree of knowledge concerning all areas of maintenance that could affect the work center. The senior petty officer must keep abreast of new ideas and be aware of the variety of directives and publications that regulate his actions. He must be knowledgeable of the factors that make him a maintenance manager, of programs that affect his work area, of his rating, and the weapon system being supported.

The Naval Aviation Maintenance Program (NAMP) OpNav Instruction 4790.2 (Series), outlines command, administrative, and management relationships and establishes policies for the assignment of aviation maintenance tasks.

The supervisor who endeavors to become thoroughly familiar with the contents of the Naval Aviation Maintenance Program Manual, Volumes 1-4, will be better equipped to handle the administrative affairs of the work center. By the time most petty officers reach the E-5 level, they should be totally familiar with the variety of source documents associated with aircraft maintenance. Use of these documents is covered in Military Requirements for Petty Officer 3 & 2, NavPers 10056 (Series). NavPers 10057 (Series), Military Requirements for Petty Officer 1 & C, provides coverage on the various manhour and maintenance data reports as well as other pertinent areas of the NAMP.

The senior AO will by necessity become involved in the variety of special programs that directly or indirectly influence the supervision of his work center. OpNav Instruction 4790.2 (Series) provides amplifying information on selected maintenance programs such as the following:

1. Component repair.
2. Foreign object damage (FOD) prevention program.
3. Corrosion control and preservation.
4. NavAirSysCom calibration program.

Separate chapters provide in-depth information concerning Quality Assurance, Unsatisfactory Material/Condition (UR) Reporting System, Planned Maintenance System, etc.

The supervisor who has had varied experience in all aspects of his rating is a definite asset to any command. A complete knowledge on one's rating is not easily achieved. All too often, personnel put in the required training courses and rely on the information retained from the Rate Training Manual to get them by. Study of the latest editions of these manuals and the additional reference material listed in NavTra 10052 will assist in the never-ending attempt to stay current. When advancement in rating qualifications change, the alert petty officer notes these changes and strives to correct any knowledge deficiencies that might exist. Curiosity regarding activity correspondence, changes and bulletins, changes to maintenance publications and other maintenance directives, as well as changes to Ordnance Pamphlets (OP's), and other sources of information which influence the supervisor's work center and/or rating, can result in increased ability and confidence.

The number of aircraft accidents, ground accidents, and incidents involving human errors has increased steadily for the past several fiscal years. As the number of errors increased, the most often repeated errors continue to be the same from year to year. Some of the errors cause little or no damage and consequently have not been appropriately advertised. Many maintenance errors can be attributed to failure of the supervisor to properly perform his duties.

A knowledge of the weapon system being supported is a must requirement. The training lectures prepared for use in training personnel within the work center should be a valuable source of information regarding the weapon system. Study of the appropriate volumes of the Maintenance Instructions Manual that affect the AO and completion of courses on the weapons system provided by the NAMTraDet's will better equip the supervisor to make decisions regarding maintenance of the systems. Use of the MIM when performing maintenance applies to both the worker and the supervisor. The complexity of many of today's weapon systems requires that step-by-step procedures be followed for accomplishing removal, installation, repair, operational testing, loading, etc. It is impossible to commit these step-by-step procedures to memory. Personnel who are unfamiliar with a task that is assigned should readily admit their lack of proper training rather than attempt the task with questionable results. It is not uncommon for a supervisor to find that a subordinate has greater knowledge of a particular system than the supervisor. If he has been to one of the NAMTraDet's courses on that particular system and/or has considerable experience, it is entirely conceivable. However, the supervisor must make it a habit to verify any doubtful information and correct any knowledge deficiencies on his part, or he may lose some of the respect necessary to maintain control of his men. This is not to imply that he should be distrustful of his men. Sometimes subordinates feel that information passed on to them by others is correct without verifying it in the MIM's or OP's. In summary, it is better to admit when you do not know something and then follow through by doing something about it immediately.

MAINTENANCE MANAGEMENT

Management has been defined as "the efficient attainment of enterprise objectives." Maintenance has been defined as "all actions taken to retain material/equipment in a serviceable condition or to restore it to serviceability." The performance of maintenance requires resources to be available and properly managed at all levels of command. Department of Defense Instruction 4151.12 (Series) has defined equipment maintenance management and stated that the goals to be achieved are those paraphrased below.

"Maintenance management is the process of developing projected workload requirements, planning, organizing, staffing, directing, and controlling the engineering, industrial, and other resources required to achieve the objective. The goals are the effective and economical support or those equipments required to achieve the operational objectives of SecNav and DOD." This definition and its applications are not limited to specified levels of command and must become a part of the maintenance managers daily routines.

The principle of management by exception is fundamental to this entire management system. It means simply that actions or incidents which vary markedly from established standards or norms are singled out as exceptions from the whole for special management attention. For example, if certain models of aircraft or equipment consistently fail to attain established material readiness standards, those models would be singled out for special study and corrective action. Within the aircraft, certain systems or components which are chronically failing and consuming abnormal numbers of maintenance manhours or parts would be exception items. Work centers which consistently fail to meet production schedules or which consistently require overtime work would be singled out for special attention. The principle of management by exception is not new. It is particularly adaptable to aviation maintenance management through the use of modern machine data processing techniques. Commanders and supervisors at all levels concerned with maintenance must consciously and intelligently apply this principle in order to most effectively use their resources in men, money, and materials.

The principles of planning, organizing, staffing, directing, and controlling must be understood and implemented if maintenance is to be accomplished in an orderly manner. Although no attempt has been made to list all management principles that may be applicable in individual situations, the requirement for effective application of a few basic principles must be recognized by all maintenance managers. It must also be recognized that mere attention to these principles cannot insure attainment of the desired results. Coordination and communication, both externally and within an activity, are the catalysts which insure the smooth functioning of a maintenance organization; their importance cannot be overemphasized.

SUPERVISION AND LEADERSHIP

The experienced petty officer will soon learn that supervision and leadership are very closely related. The supervisor's role requires that he be a leader, a man of common sense, and a man who earns the respect of others. Many decisions are difficult to make. To be effective in his decision making, the supervisor assembles pertinent facts, policies, and procedures; develops a course of action and evaluates possible alternatives; selects the best course of action; and initiates the required action. When necessary, he consults his own superior prior to taking action. Every supervisor must face problems squarely and make timely and sound decisions. The supervisor who dodges his responsibilities will soon find his control of subordinates slipping away, discipline deteriorating, dissatisfaction with his supervision increasing, and effectiveness of the organization suffering.

The supervisor who establishes and maintains a spirit of cooperation within his work center and in the everyday dealings with other work centers and maintenance control will find his job is much easier. Readiness is the common purpose of the naval organization, and all ratings should share a common interest in achieving that purpose. A willingness by each individual to submerge his personal interests in favor of getting the job done is a necessary prerequisite to cooperation. If the supervisor's requests are reasonable, made well in advance (when possible), were understood, and provided all the necessary information, his requests will generally induce cooperative action. If cooperation is lacking, check the facts to find out why. If subordinates are at fault, they can be told directly and in a firm manner, taking into consideration the basic principles of good leadership.

The supervisor's duties involve planning, direction, and control. Careful planning is an essential ingredient to effective supervision and minimizes other types of supervisory efforts when carefully executed. Time and effort invested in the process of careful planning is rarely wasted. It can result in job simplification and increased efficiency.

The effective supervisor initiates the planning process by identifying each specific job to be done by his men. With a routine clearly established, he can spend his time on the exceptions that may arise. He knows the capacities, interests, weaknesses, and potentials of his men. Knowing each man's level of technical skill, motivation, ambitions, and personality characteristics will enable the supervisor to (1) assign the right man to the right job, (2) identify the training needed by each man to do a better job, and (3) establish the standard at which each man can be expected to perform.

Once action has been initiated, the supervisor provides direction. This function of supervision is like that of a "foreman." He sees that work is started and knows what is going on at all times. This does not mean that he must always be physically present while the job is being done. Subordinates should be trained to assume responsibility for the job in the absence of the supervisor so that no man is indispensable, including the supervisor. The supervisor should, however, be available when his men are working, and they should know how to contact him. The supervisor should always be present when his men are assigned new tasks, when they have trouble getting a job done, or when other circumstances dictate the necessity for his presence. He must be careful not to oversupervise lest he destroy the initiative of his workers and subordinate supervisors. He receives suggestions and reactions from his subordinates and acts as necessary on them, giving credit when and where it is due. Recognition of each man as an individual is required.

Control of a job refers to the function of checking to see that the job is done as planned—a comparing of performance with plans. Deviations may reflect poor planning. However, procedures should exist whereby changes in plans that could result in improved performance can be implemented to minimize repetition of faulty performance.

The supervisor will be challenged to allocate sufficient time to be expended on planning, direction, and control. A spirit of firmness, fairness, cooperation, decisiveness, harmony, and mutual respect while seeing that the job is done will rarely go unrewarded.

Communications

The area of communications as related to supervision and leadership is singled out here because of its importance. Almost without exception, problem areas regardless of their nature can be attributed to the lack of proper communications. Men like to be kept informed about all the things that affect them. Keeping them informed will improve their morale and generally make them more responsive to the needs of the command. The supervisor can improve morale by keeping his men as well informed as possible concerning need-to-know and nice-to-know information that could affect them, as long as it is not classified.

Communications is a two-way process. The supervisor must be able to convey his ideas, orders, etc., and pass on information, either orally or in writing, in such a manner that it will be clearly understood. He must also be willing to listen to and try to understand the ideas of others. Subjectivity (that is, looking at things only from a personal viewpoint, because of your position, rating, pay grade, or any other reason) will hinder communications. Bias and limited knowledge can limit a supervisor's ability to be objective, and by recognizing this fact he can listen more objectively.

Ridicule, sarcasm, vulgarity, etc., have no place in good communications. The supervisor who must get loud and resort to such language to get his point across or the job done needs to realize how adversely such action affects his own feelings of importance and respect. When it becomes necessary to orally reprimand a subordinate, do it in private, keeping in mind that he is an individual and as a petty officer he must have the respect of the men under him. If a supervisor reprimands a man in public, both lose respect and are less effective in getting the job done.

Professionalism

It is the responsibility of all senior petty officers to instill a spirit of professionalism in their subordinates. Aviation ordnance is a reasonably complicated and dangerous profession that leaves little room for error. The AO who gives it less than his undivided attention presents a potential hazard.

The responsible petty officer sets the example he wishes others to follow, doing the right thing in carrying out each assignment, including (and especially so) when no one is watching. Undiluted professionalism means that there is no room for ethical lapses or occasional breaches of integrity. The worker who even once shortcuts established procedures, does not follow mandatory instructions, sacrifices quality for speed, or performs any other action which could produce a negative judgment towards him lacks the professional integrity demanded in aviation ordnance. The supervisor who condones such action is equally guilty of a less than professional attitude and the results that such actions could cause.

There is no substitute for thorough knowledge of your aircraft, your weapons, your job, and the procedures associated therewith. Correct maintenance procedures and thorough quality assurance will almost always produce professional results. Aviation and ordnance safety demands pure, undiluted professionalism from all personnel involved in maintenance.

SCHEDULING

A supervisor should include known future assignments in the work schedule. If it is known that on a certain date certain jobs must be performed, the work schedule can be arranged so that routine work will have already been accomplished.

One of the most important aids in supervision is a job plan. When setting up a job plan, consider these questions:

1. What is the job?
2. How can it be accomplished?
3. How many men are required?
4. What tools and materials are necessary?

Determining which jobs should be performed first will be one of your major responsibilities. This is an important phase of your work for these decisions determine the use of your facilities—men, material, and machinery. Routine work presents no particular problem to a well-organized shop. However, rush jobs can cause confusion unless you have already thought them through and taken steps to see that the work follows well-founded principles.

When scheduling work, insure (if practical) that the men or crews will be working on different types of jobs. If a number of men or crews are assigned to the same type jobs there may be an overdemand for certain test equipment, tools, and workspace. This often results in confusion and loss of time.

It is also important to schedule activities so that work is accomplished in the proper sequence. This is especially important if you have men working on different phases of the same job.

Future job assignments should be included in the work schedule so that time will be allotted to accomplish them. This may make it necessary to rearrange the present work schedule to insure that special jobs will not interfere with the accomplishment of routine work.

CHECKING PROGRESS AND EVALUATING PROCEDURES

The assignment of work is only the first step in processing a job. The AO who is in charge must know his men. He should have a fairly good idea of each man's skill and ability, as well as each man's knowledge regarding the operation of equipment and the accomplishment of repair work.

The best way in which the AO supervisor can obtain this knowledge is to make frequent inspections and check the progress of work being performed. In that way, he will have a good idea as to which jobs, or which men, will require the most supervising.

When checking on the progress of work, the senior AO should be sure that the men are observing proper safety precautions in regard to themselves and the equipment they are operating. In addition, he should see that each man is using the proper tools, and note the quality of work being performed.

In case of any doubt, the supervisor should check to see that the men understand his instructions properly and are doing the work correctly. If necessary, he should provide additional instructions to give a better understanding of the job, or to improve workmanship. By frequently talking to the men and answering their questions, the supervisor can prevent work and material from being wasted, as could be the case if he were not available to give the correct details.

Incorrect procedures by an AO have caused numerous accidents with the unnecessary loss of lives and material. The AO supervisor must constantly evaluate the procedures used by his command to ascertain that all applicable directives are rigidly followed. The omission of one step in assembly of a weapon or aircraft loading can be deadly. The supervisor must insure that all personnel that work with aviation ordnance material are thoroughly trained and certified in accordance with OpNav Instruction 3571.3 (Series).

QUALITY ASSURANCE

All work completed is subject to inspection by the crew supervisor and quality assurance inspector. The inspection is performed to aid in the reduction of human error and to insure that all material used was of the proper type and quantity. Quality assurance inspections are not used to replace the responsibility of the crew leader or supervisor but to enhance the reliability of a weapon or weapon system.

Generating quality in an organization necessitates a sincere interest on the part of commanding officers, plainly evidenced to the officers and men in their commands. Quality further requires that each officer and supervisor understand clearly how the accomplishment of a quality job contributes to the effective operation of the organization. Quality also requires each worker understands not merely a set of specification limits, but also the intent and the need for these requirements.

The quality assurance organization is concerned with three functional areas—quality management, quality verification, and technical publications.

Quality mangement is monitored by formulating, implementing, and auditing procedures, instructions, and operations to assure compliance with the policies stated or implied within the NAMP Manual. Quality assurance coordinates their efforts with those of the activity's data analysis group to provide information on maintenance practices and results based on facts gleaned from the various maintenance source documents and associated reports.

Quality verification assures that all materials processed and actions taken by all personnel meet prescribed quality requirements. Direct inspection of material and operations as they are performed is necessary on a continuing basis to give adequate assurance that all items processed and tasks completed meet the prescribed requirements. These quality assurance considerations (tests, inspection, etc.) are included in most weapon system Maintenance Requirements Card decks as well as most Maintenance Instructions Manuals, Overhaul and Repair Manuals, and Ordnance Pamphlets (OP's). Quality assurance verification steps are generally called for at various steps during repair progress in addition to verification of the final product.

Inspectors

Personnel to be designated as inspectors should possess the following attributes:

1. Should be experienced and fully knowledgeable within his technical rating.
2. Should possess the ability to research, read, and interpret drawings, schematics, technical manuals, and directives.
3. Should be able to write with clarity and technical accuracy.
4. Should be observant, alert, and inquiring with a record of excellence and stability in the performance of his duties.
5. Should be able to work with others and possess the personal desire and motivation to develop a greater knowledge of his technical speciality.
6. Should be a senior in his paygrade and experienced.

Each man designated as an inspector should receive an indoctrination on quality assurance objectives, policies, and procedures as provided in OpNav Instruction 4790.2 (Series). The indoctrination requirement is directed toward developing an appreciation for the importance and necessity of an organized quality assurance effort on a continuing basis.

Training of Inspectors

Training of personnel involved in quality assurance and collateral duty inspection requires continuous training in weapon system familiarization, repair procedures, troubleshooting techniques, inspection, testing, and quality assurance considerations specifically applicable to their areas of maintenance.

Quality assurance representatives verify the adequacy and accuracy of inspections performed by the collateral duty inspectors of the work center. Collateral duty inspectors are permanently assigned to the work center and, in addition to other assigned duties, they are assigned to inspect work accomplished by other personnel within the work center. Both the representatives and the inspectors are designated in writing by the commanding officer. Only those personnel designated in writing are authorized to sign as inspectors on maintenance forms or to certify in any way that a component or equipment is ready for issue or use. A sample inspector designation form is provided in OpNav Instruction 4790.2. Copies of the form are kept in the quality assurance files and the division officer's files, with the original going in the man's service record.

Weapons Department Quality Assurance

The Weapons Department aboard a CVA utilizes quality assurance inspectors during the assembly of ammunitions; i.e., bombs and rockets, to insure that the completed round has been assembled correctly and contains the proper fuzing when applicable. Maintenance performed on bomb elevators, handling equipment, magazine sprinkler systems, and magazine storage configurations also are inspected to insure that all applicable instructions and safety precautions have been followed.

Aircraft Squadron Quality Assurance

Since technical information has a direct relationship towards assuring the quality of work performed, the quality assurance division of an aircraft squadron has the responsibility of operating a master technical library and monitoring of dispersed libraries within the various work centers. Dispersed libraries located within the work centers are necessary to place technical information in the hands of the user who is charged with compliance. The quality assurance division monitors the operation of these dispersed libraries, providing new publications, revisions, cancellations, and such other information that may affect the publications held. A change entry certification form is utilized to insure that all change and revision material is entered into the directives and manuals of the dispersed libraries within a reasonable time.

Quality assurance functions previously discussed in this section are also applicable to AO's in an aircraft squadron.

Quality Assurance Audits

An audit plan that encompasses all areas of work performed in the maintenance department is developed by the quality assurance officer and is utilized to audit each work center at least once quarterly. The audit plan is designed to evaluate the adequacy of technical documents, the quality of work being performed, and the validity of related maintenance and quality assurance inspection procedures.

Internally caused deficiencies are reported to the appropriate supervisor with requirements for corrective action.

Externally caused deficiencies are discussed with the work center concerned and a complete report is submitted to the maintenance officer with comments and recommendations for remedial or corrective action as required.

DISCREPANCY TRENDS

By careful and continuous reference to the daily discrepancy reports, work order requests, work logs, etc., many times a definite trend in discrepancies can be detected. Detection in itself is not difficult. The big problem is reducing these indications to basic causes or reasons for such trends. Sometimes they can be traced to improper maintenance procedures such as a misalinement caused by maintenance personnel not adhering to specifically outlined procedures. Perhaps the problem will be revealed by an investigation of test equipment being used. Such an investigation might disclose improper operation of test equipment. It may be found that error tolerances have been exceeded. Other times an equipment deficiency, especially in newer type equipments can be "pinned down" as the reason. No matter what the cause, an analysis of the problem is required when a trend in discrepancies is noted.

A discrepancy trend may be indicated by the failure of several parts or components under similar circumstances, if the history of the items is known. Discrepancy trends may also be detected by studying the NavAirSystems Reliability Digest (NavAir 00-65-501), which is published monthly by the Naval Air Technical Service Facility (NATSF) and distributed to all units concerned with Naval aircraft. The information contained in the Reliability Digest is collected from Unsatisfactory Material/Condition Reports (UR), OpNav Form 4790/47, and many other sources.

ANALYZING DEFICIENCIES

In order to properly analyze any problem, the ordnanceman must have a thorough understanding of the operation of the equipment being maintained and of the test equipments necessary to maintain it. Armed with this information and with a sincere and conscientious approach, almost any maintenance problem can be deliberately and systematically resolved in reasonable time. Most of the difficult and many of the seemingly impossible problems have been solved by careful and painstaking testing and recording of indications obtained through voltage and resistance checks and the application of basic theories. The more difficult the problem the more exacting must be the applied procedures and tests.

The major contribution to analyzing a problem is a clear and orderly thought process. The ordnanceman must provide this ingredient since test equipment, charts, and tables will only contribute the necessary materials to be used in these thoughts.

While the ordnanceman is involved in analyzing these deficiencies, many times he will discover a better method of maintenance or find a potential trouble spot in the equipment for which he may help find a solution by making known a suggestion to remedy the situation. By so doing he will be aiding in the entire program of improving productivity by saving manhours and material.

Value Analysis

Value analysis in maintenance operations can be defined as a systematic and continuing evaluation of those factors affecting the efficient maintenance of a component, equipment or system. It encompasses functional as well as engineering design standardization, and reliability as well as ease and frequency of maintenance operations. The ordnanceman accepts his responsibility to keep the equipment in readiness and conscientiously attempts to "keep them flying." He will not knowingly compromise the functioning of equipment under his jurisdiction even though occasionally he must ground aircraft because of insufficient time to complete a job. When an aircraft is grounded it affects the fulfillment of the Navy's mission. Value analysis, if objectively and actively pursued, can result in increased maintenance efficiency by saving manhours of shop time and can thereby result in fewer grounded aircraft.

Through value analysis, and through human and design engineering, efforts are continually being made to build maintainability and reliability into all new components, equipments, and systems.

DEVELOPMENT OF INSPECTION PROCEDURES

In developing good inspection procedures, it is necessary to first establish an acceptable quality level of work, keeping in mind that safety must always come first. Next a continuing procedure for analyzing discrepancy trends must be created; records must be kept; and followup action must be provided to stimulate improved workmanship. The crew's thinking must be influenced so as to incorporate principles of quality control in each step of the job. Ordnancemen should be encouraged to help each other by double-checking each other's work as they go along. Any job is properly accomplished by first delegating it to those who can and should be doing it; therefore, the best qualified ordnancemen must be assigned to perform the inspection. Insure that these men have all the specifications and records needed to perform the inspections. Every man in the crew must understand that an inspection is not to fix blame or to comply with a requirement, but to save aircraft and lives and to provide the best operating equipment possible.

The morale and physical condition of the crew are equally important as their technical ability. If a man works beyond his physical capability, he does not take time to do each job with painstaking care. Morale, which is a product of leadership, plays a vastly important role in the maintenance program since it can so adversely affect the flight support effort. This in turn will deny a good safety environment regardless of the fact that the maintenance personnel are well trained. The supervisor must set a good example because people try to imitate or take for their own those qualities they admire in those they identify as their leaders. If the leaders are respected and admired as good, aggressive, professionals who create by their interest and actions a good attitude toward flying and safety, then the maintenance program will be good.

With good leadership we are assured of high morale. This combined with good maintenance training and good quality control will insure good maintenance and flight support.

BRANCH MANAGEMENT

Management at the armament branch level is normally supervised by the senior AO assigned. The supervisor has many responsibilities associated with personnel, material, and combat readiness to carry out. With proper leadership and attention to detail, the supervisor can instill the driving power in his subordinates to meet the commitments of his command. Some of the responsibilities of a supervisor at the branch level (or any crew) include the following:

1. Accomplishment of all assigned work.
2. Maximum utilization of personnel and facilities.
3. Recommending the repair capabilities and facilities of the work center to the higher echelon.
4. Inspection of all completed work when required.
5. Initiating material requirements to support the present and projected work center requirements.
6. Completing and forwarding all required reports.
7. Maintaining records as required.
8. Coordination of the work center tasks through maintenance control.
9. Organization and control of the work center training program to support the department and command training program.
10. Monitoring the NAMP (OpNav Instruction 4790.2) documents for completeness, accuracy, and timely submission.
11. Recommending necessary changes in methods and techniques to promote maximum safety, material readiness, and combat readiness.

Zero Defects

The "Zero Defects Program" was developed by the Navy for a continuing effort to improve the overall work efficiency of equipment and personnel. The goal of the program is applicable to all activities (and supervisors) concerned with the production, maintenance, and handling of aeronautical equipment.

The supervisor at the lowest level, up to and including the CNO, is responsible for reducing the incidences of error caused by lack of proper training, facilities, equipment, procedural methods, quality assurance, control programs, and motivational concern.

The concept of the program is to complement other motivational effort programs including the following:

1. Cost reduction.
2. Beneficial suggestions.
3. Incentive awards.
4. Value engineering.
5. Quality assurance.
6. Aviation safety.

Commanding officers and officers in charge are responsible for implementing the zero defects program and designating a qualified officer as coordinator. The quality assurance officer normally performs this function at the organizational and intermediate levels. The work center supervisor, under the guidance of the program coordinator, will control and direct at the work center level to achieve zero defects on all tasks completed by his crew.

The loss of lives due to human error can be vastly reduced by each man performing at his best on all tasks assigned. The crew leader, supervisor, and quality assurance inspectors are used to check completed work to provide a check system against "Murphy" type errors, improper performance, and oversights. The goal of the zero defects program can be accomplished only with each man taking pride in his accomplishments and striving to learn more, never resting on past accomplishments.

Work Simplification

Work simplification is a common sense, systematic method of identifying and analyzing work problems, developing solutions, and installing improvements. In order to achieve maximum efficiency each supervisor must do his part to improve the work situation and achieve maximum manpower utilization. This implies that the greatest possible use of all resources available be made in order to help accomplish an activity's mission. Work simplification is a tool which can be utilized effectively in the accomplishment of this goal. Work simplification might be considered as human ingenuity applied to the work situation. It is the organized use of common sense and creative thinking in the solution of work problems.

If all men had believed that there could be no better way of doing things, we might still be throwing rocks at game for our food and traveling from place to place on foot. Progress in these fields was not made in a single step but in a series of improvements. These changes occurred slowly over the centuries, growing out of a multitude of small improvements.

The supervisor who lives day to day, satisfied that what he did yesterday is good enough for tomorrow, will, in most cases, leave his job no better from having held it. He leaves nothing significant for other personnel to follow him in his job, and he becomes lost in the shuffle of men who are content with merely living and dying.

The majority of improvements in our world did not come by accident; rather, they came as a result of man's ingenuity, growing out of his sense of imperfection and his constant search for improvement. When an improvement is made, no matter how small, it marks its discoverer as a person of imagination with a real and active interest in his work.

The supervisor who believes in and practices work simplification procedures can look with pride upon his contributions or those of people who work with him. This means that the supervisor should never cease to search for improvement and must encourage his workers to try to improve jobs over which he has control.

The supervisor should always watch for areas where work can be simplified. Work simplification pays immediate dividends by increasing both production quality and quantity. It allows the supervisor to meet work schedules more easily and reduces waste by producing with less effort, increases savings in time and manhours, and thus reduces cost of operation. Work methods improvement aids in establishing standard procedures. These standard procedures aid in training both old and new workers, since most workers are easier to train, and learning is much easier if standard practices are used.

An example of work simplification that is widely used in maintenance activities is a reports tickler file. The tickler file contains information on each report concerning the kind of report required, form or format to be used, due date, address of the office or command to which it is sent, etc. Although the governing directive should be consulted when preparing a report, a properly used reports tickler file simplifies and assists in the preparation and timely submission of required reports.

Work simplification should be considered when arranging the shop equipment (intermediate maintenance) in the work center. Equipment should be located so that ample room is available to accommodate its use. When possible, equipment should be arranged in a logical manner so that jobs requiring the utilization of several items of equipment can be used in a manner similar to that found in assembly line operations. In a like manner, visual information display boards and/or status boards utilized to control maintenance should be located where they can be easily viewed and kept current without disrupting other personnel.

It is true that with good leadership personnel can be encouraged to work to the limit of their physical endurance but unless their efforts are used wisely, the most critical resource—manpower—is being wasted. In the final analysis, it is not how hard personnel work but how much quality work is accomplished that matters. Therefore, to help achieve maximum results with minimum expenditure of human effort, the supervisor should always strive to use established work simplification techniques.

Work simplification permits continuous evaluation by analyzing existing methods and procedures with a view toward improving them. There is always a better way of performing a task by using streamlined methods, improved tools, better working conditions, or shorter procedures. However, these better methods are not always apparent. Work simplification should be directed at all work situations where physical effort is expended.

TECHNIQUES.—There are many techniques for improving work methods. For the most part, these techniques are adaptable to any work center or production control as well as the whole activity. Five of the principal techniques which have been successfully applied to work operations are discussed briefly.

Work Distribution Analysis. Work distribution analysis is a technique used to analyze objectively the division of work in an organization. In order to obtain the most effective distribution of work, it is necessary for the supervisor to have an overall view of the organization and its operations. The supervisor must clearly understand the work that is being done and be able to see the relationship between the overall operation and the individual work units as well as the contribution that each person makes to the work of the whole organization.

Distribution of work is an important factor in efficient use of manpower. Time and effort are saved if related duties are performed by the same person. Thoughtful matching of assignments and qualifications is important so that personnel are not struggling with work that is too hard for them or wasting their time on tasks that might be performed by a less skilled person. Another consideration is distribution of workload to avoid inequalities, since these result in bottlenecks and other inefficiencies.

Work distribution analysis requires that a Task List be completed for each person whose work is being studied. This list contains, in simple statements, tasks the worker performs regularly and the average number of hours spent on each task per week. Next, a Function List is prepared which lists each function performed by the work center. Each task reported on the Task List must be related to a specific function. A Work Distribution Chart is prepared from the data collected on the Task List and Function List. This chart presents the work performed in the existing organization under current operating conditions. The chart is then studied and analyzed to find answers to questions such as the following:

1. What functions take the most time?
2. Is there misdirected effort?
3. Are skills being used properly?
4. Are personnel doing too many unrelated tasks?
5. Are tasks spread too thinly?
6. Is work distributed evenly?

A careful study and analysis of the work distribution chart should assist in achieving the following results:

1. Elimination of unnecessary tasks.
2. Reduction of time spent on relatively unimportant functions.
3. Elimination of duplication and overlapping of work.
4. Better balance of workloads.
5. Combination of related tasks.
6. Realistic estimate of personnel needs.
7. Better utilization of skills.
8. Reallocation of misassigned personnel.

Work Count Analysis.—Work count analysis supplements the work distribution analysis and is a technique for determining the volume of work in terms of measurable units. Information obtained by counting or measuring the work provides a basis for improving methods and procedures, adjusting work assignments, evaluating performance, and eliminating bottlenecks. Such information is useful in assigning and scheduling work to insure that the workload is equitably distributed among all personnel.

Items of work counted should be definite and comparable. Items counted should also be representative of work usually performed. Only those should be counted that clarify methods employed. Counting may take place where the work comes into production control, where a decision is made or action is taken, where a process is completed, or where long storage occurs.

Work count information can be used to accomplish the following:

1. Establish how long it takes to do a given piece of work.
2. Indicate whether the volume of a certain piece of work is sufficient to warrant specialization.
3. Show whether work is distributed evenly among workers.
4. Point out bottlenecks where work piles up.
5. Indicate whether the work center is adequately manned, overmanned, or undermanned.
6. Stimulate interest of personnel by providing comparisons of one person's work with that of another or with his own record during a different counting period.

Flow Process Analysis.—Flow process analysis is a technique for analyzing flow and sequence of operations. The purpose of this analysis is to reduce time and distances in a process by eliminating, combining, and changing the sequence of steps in the flow of work.

The principal tool of this technique is the construction of a flow process chart which provides a clear and detailed picture of the flow of work. Recording each step in a procedure helps to identify duplication of effort, backtracking, and other obstacles to the smooth, efficient flow of work.

Motion Analysis.—Motion analysis is a technique for making maximum use of physical motions. It is a method of studying the motions of individuals in performing their various tasks.

Work distribution and flow process analyses are directed toward improving the division and flow of work. Motion analysis deals with how an individual performs his tasks. It seeks to learn whether the workers are doing their work with minimum fatigue, loss of time, and waste of effort. Improvements are effected by rearrangement of materials and work area and by proper use of equipment.

The simplest way of gathering data for motion analysis is for the supervisor to watch his personnel at work and note useless motions. Motion analysis should result in the elimination of wasteful motions and consequent loss of work time, reduction of fatigue by lessening the amount of physical effort required to complete a task, and increase the efficiency of personnel.

Layout Analysis.—Layout analysis is a procedure designed to lead to better utilization of space, personnel, and equipment. A study of the layout of a working area can provide useful information for improving the work of individuals, distribution of the workload, and flow of work from one person to another. Its purpose is to determine what space is needed for the operations to be performed and how the available space may be used most effectively. Besides shortening and simplifying motions, it should produce work conditions that are as comfortable and personally satisfactory to the workers as possible consistent with efficient and economical operation.

The layout chart is the principal tool of this type of analysis. This chart consists of a floor plan of the work space, showing doors, windows, electrical outlets, etc. All features that restrict usable space should be included. Items of projected new equipment should be added and the anticipated flow of work indicated.

WORK CENTER AND ARMORY ORGANIZATION

Most Aviation Ordnancemen will never have the opportunity to plan the organization of an armory or armament branch work center. In most cases the AO will take charge of an already functioning work center or, when his squadron or unit deploys or moves to a new base, he and his crew are usually assigned to spaces already basically equipped for armament maintenance. In either case, a reevaluation of the work center's layout is indicated.

WORK CENTER LAYOUT

The reevaluation of the layout should include determining, from the applicable allowance lists, if the equipment allowances have changed in any way. There is no use relocating equipment which involves rewiring or plumbing work if improved replacement models are authorized and available.

A basic consideration in planning a work center layout is its purpose. When more than one space is available, the supervisor must decide which will most nearly fill the requirements of space, ventilation, lighting, and the distance from flight line and hangar. This decision should be based on factors of safety, economy, functional compatibility, and convenience.

Equipment Arrangement

The arrangement of the work center equipment should be made on the basis of utility rather than appearance. Moving an item of equipment into an out-of-the-way corner may greatly improve the appearance of the work center but at the same time reduce the efficiency of personnel using the equipment and may possibly create a safety hazard. A good rule to follow is to locate equipment where it can be safely used by the greatest number of people with a minimum of effort in the least amount of time.

Work tables and benches should be positioned with respect to fixed equipment so that the equipment most often used is most quickly and easily reached. Electrical and compressed air outlets should be readily available to the workbenches. Needless delays are caused by having to rig unnecessarily long connections from poorly located outlets.

Near workbenches where specific and intricate maintenance functions are performed, consideration should be given to installing special lighting such as explosion-proof, vapor-proof, or interference-free type lighting. Under certain conditions, special lighting may also include floodlights for outside work areas and in hangars when improved lighting is required.

Utilization of paint in various colors to emphasize portions of intricate machinery for safety and reflective purposes is known as dynamic painting. Painting in this category should not be utilized for normal building maintenance.

A system of stowing tools must be devised. An intelligent system cannot be set up without first determining from allowance lists what tools will be required for satisfactory operation of the work center. The place for all tools should be marked or otherwise specified, and everything not being used should be kept in that place.

The layout should make provisions for a bulletin board upon which may be posted safety posters, maintenance posters, instructions and notices, plans-of-the-day, and such other information as is appropriate from time to time. The bulletin board should be located in a prominent place in the work center, preferably near the entrance where everyone assigned will have to pass at some time during the day. Material on the bulletin board should be changed frequently, expired notices promptly removed, the current plan-of-the-day posted early, and other posters and material rotated periodically. If the same material is presented in the same format every day, it will not be long before the men begin to ignore the bulletin board and purposes for having it are defeated. New arrangements are noticed and interest is stimulated with variety.

When aviation organizational level maintenance activities are moved aboard ship, their working conditions and accommodations are drastically affected. The ingenuity of the supervisor will be required to produce a workable arrangement within very limited spaces. Stowage racks for toolboxes and other work center equipment should be located to accommodate their frequency of use. Some equipment used at less frequent intervals may have to be stowed in voids. An inventory listing of such items, showing their specific location, will be necessary. Security of material stowed in voids, toolboxes, and other equipment will require more attention than when ashore. Gear not properly stowed and afforded appropriate security has a habit of disappearing, and during rough sea states, can be hazardous to personnel and/or other equipment.

Much of the work done aboard ship will have to be done under less than ideal conditions. Confined spaces, reduced lighting during nighttime flight operations, hazardous conditions on the flight and hangar decks, problems associated with respotting of aircraft to accommodate maintenance, and a variety of conditions peculiar to ship operations will require modification of procedures used ashore. The supervisor should insure that spaces are utilized to their fullest extent.

Since most organizational level maintenance is "on aircraft" type maintenance, the limited space of the work center should present only a minor problem concerning the stowage of gear and some personnel congestion during periods when personnel are awaiting work. Consideration of the factors previously discussed under "Work Simplification," and further discussed in NavPers 18359 (Series), could result in a smoother transition from shore to shipboard facilities and vice versa.

ARMORY LAYOUT

Squadron armories aboard carriers are usually located one deck below the flight deck (0-2 or 0-3 deck). Most armories have both 28-volt d-c and 115-volt a-c outlets for test equipment and power tools, compressed air connections, adequate work and test benches, and are well lighted and ventilated. They are convenient for work performed on aircraft spotted on the flight deck, but less so for aircraft maintenance performed on the hangar deck. There is little occasion to change the layout as most of the equipment is rigidly fixed.

Shared Spaces

It may be necessary to share an armory or working space with another squadron or unit while deployed to an advanced base or aboard ship. Other than having less area to work and store equipment in, this should present no major problem if an intelligent arrangement is worked out with your corresponding member in the other unit.

Consideration must be given to each squadron's mission if different types of aircraft are involved. Friction between units can be avoided if the details of cleanliness, upkeep of spaces, and security are equitably worked out and a schedule posted.

Stowage of Cruise Boxes and Loose Equipment

The stowage of cruise boxes and loose equipment is necessary whether deployed or at home base. The multiple-mission capability of today's aircraft requires many different adapters, control boxes, fairings, etc., which are normally part of the aircraft inventory and must be strictly accounted for. They should be stored in a dry and secure space when not in use.

Cruise boxes are usually of the type which will collapse and fold when not in use and may be stacked to conserve space. Aboard ship they must be securely tied town to prevent them from shifting in heavy weather.

UTILIZATION OF SHIPBOARD STOWAGE AREAS.—Aboard ship space to store equipment is always at a premium. Items which are frequently used should be stowed in the most accessible spaces while those which are bulky or seldom used should be stowed in the more inaccessible areas. Flammable or explosive items must never be stowed in other than approved spaces (check with the ship's fire marshal for approval).

PERSONNEL MANAGEMENT

One of the problems that a supervisor will encounter is that of personnel management. The supervisor must realize the importance of long range planning to insure that his personnel are trained and available to complete scheduled deployments.

To assist the operating activities in their personnel management, a Manpower Authorizations, OpNav Form 1000/2, is furnished each activity listing by pay grade and NEC the number of personnel authorized. The authorized manpower is the result of extensive study by NavAirSysCom; it is based on the weapons system, the type of operations being conducted, and the recommendations of the supplying contractor.

It is the responsibility of the supervisor to compare both the number and grade of personnel and their NEC's with the authorizations. Any variation in the two should be reported to the department/division officer as appropriate with recommendations based on facts.

If the manpower authorizations differ (in number, pay grade, or NEC) from actual requirements of the organization and this difference cannot be corrected by training, this should be reported to the department/division officer. A Manpower Authorization Change Request, OpNav Form 1000.4A, should be initiated to request appropriate changes. OpNav Instruction 1000.16 (Series) provides instructions for preparation of Manpower Authorization Change Requests.

A document which the supervisor should utilize in the management of personnel is BuPers Report 1080-14. This monthly report, which is normally maintained in the Enlisted Personnel Office, contains a multitude of information such as expiration of enlistment, time in service, NEC codes, and projected rotation month. For those activities classified as shore duty, the tour completion date reflects the month and year a man is to be transferred; for sea duty activities, the report indicates the month and year that the man's sea duty commenced.

Personnel who have been ordered to report for duty are also covered by the report.

Utilization of this report by the AO supervisor permits long range personnel planning for school quotas, leave, and rotation of billets within the division.

SAFETY

The Chief of Naval Operations at the direction of the Secretary of the Navy is assigned the responsibility for implementation, direction, and supervision of the Department of the Navy Safety Program. This assignment was made to coordinate the effort and provide positive overall supervision through the chain of command. In this respect, safety becomes an inherent responsibility of command. Command implementation comprises those functions associated with command in carrying out safety policies and directives, and in amplifying safety guidance where necessary. The objective of the safety program is to establish an effective, aggressive, and continuous accident prevention program with the goal of enhancing operational readiness by reducing deaths and injuries to personnel as well as losses and damage to all Navy material from accidental causes.

AVIATION SAFETY PROGRAM

The activity safety officer is required to provide safety education throughout the command as well as to insure that safety standards and procedures are incorporated into all activity functions. Other equally important tasks include translating data concerning accidents and mishaps into useful and meaningful information for activity use, monitoring the existing environment for hazard potential, and keeping the activity advised in matters concerning safety and accident free operations.

The key to this program as with many other programs is effective communications at all levels of command. A variety of publications are afforded to the safety officer and key members in the safety program. The Naval Safety Center helps to promote safety in aviation and other areas of operation through various safety oriented publications. Most of the publications are automatically distributed to aviation squadrons, ships, staffs, and shore activities. Each publication is intended for a primary audience but, in general, can be useful source material for a complete safety program. A brief introduction to these publications is provided in the following paragraphs.

APPROACH MAGAZINE, the Naval Aviation Safety Review, is published monthly for the benefit of all levels of naval aviation. It contains articles on flight operations, flight surgeons' notes, maintenance commentaries, and short features with the purpose of presenting the most accurate information currently available on the subject of aviation accident prevention.

MECH, the Naval Aviation Maintenance Safety Review, is published quarterly and is directed at the enlisted aviation maintenance personnel. It presents the most accurate information available on maintenance-caused mishap prevention and general aviation ground safety directed at reducing maintenance errors and handling mishaps. Contents of MECH are intended to be informational and should not be considered as orders, regulations, or directives.

FATHOM is published quarterly and is of special interest to submariners and surface ship personnel. It does contain material of interest to all hands such as articles of general educational interest, statistics on accidents and incidents, and provides recommendations for improving shipboard safety.

CROSSFEED, Cockpit and General, is a monthly newsletter which provides a medium through which the experiences of operators of specific aircraft can be shared with others who operate the same type aircraft. The Cockpit Crossfeed is directed at the commanding officer, pilots, and crewmembers of specific aircraft. It contains sections prepared by aircraft analysts for types of aircraft based on selected accident, incident, and ground mishaps as well as accident rate tables. General Crossfeed is directed at maintenance managers and personnel concerned with specific aircraft. It contains articles directed toward the solution of maintenance problems for these particular aircraft, sections on specific maintenance areas, personal/survival equipment, facilities, accident investigation, and Naval Air Training and Operations Standardization (NATOPS) status reports.

WEEKLY SUMMARY OF MAJOR AIRCRAFT ACCIDENTS contains safety discussions, accident briefs, statistics, and safety tips. It is provided primarily for command considerations.

SHIPS SAFETY BULLETIN is a monthly publication and is the counterpart of the Weekly Summary of Major Aircraft Accidents. It contains articles on current shipboard safety problems, trends, accident briefs, and statistics pertaining to ships safety.

The Safety Center also provides posters featuring the various aspects of operations at sea, in aviation, and ashore. They are available on request from the NavSafCen. Articles for these publications are submitted by fleet activities and training commands. Personnel with safety related experiences that might benefit others should pass it along to the safety center for consideration. Most of these publications are intended for more than one reader, and the information contained in them should be appropriately disseminated.

The safety program established at the maintenance department/division level must be a primary concern of all hands. It requires active participation by all personnel on a day-to-day basis to obtain the desired results. The quality assurance division is assigned overall responsibility for the safety program at this level and establishes a coordinating group to assist in implementing the total safety plan of the activity. The quality assurance plan for the activity includes the safety program requirements. Lower level directives are prepared as necessary to insure proper implementation throughout the department/division. Items given attention in the maintenance safety program include, but are not limited to, the following:

1. Dissemination of appropriate safety posters and literature.
2. Reporting of all accidents, incidents, and unsafe practices in the department.
3. Conducting of safety meetings within the department/division. The minutes of these meetings and pertinent agenda items should be published and made available to the maintenance supervisors concerned.
4. Participation in activity safety surveys as may be required by higher authority. Safety Review Checklists are available from the Naval Safety Center as an aid for conducting safety surveys.

Effectiveness and safety result from properly trained personnel using properly designed equipment in accordance with established procedures under competent and persistent supervision.

Aircraft maintenance and the handling of explosives and pyrotechnics are to some extent, naturally hazardous due to the nature of the work, the equipment involved, and the sensitivity of ammunition and pyrotechnics. Factors which can function to increase or decrease these hazards include the following:

1. The experience levels and mental attitudes of assigned personnel.
2. Tempo of operations combined with haste and inattentiveness.
3. Unnecessary risk or disregard of common safety practices.
4. Disregard or unawareness of technical and safety directives.
5. The quality or lack of supervision of the maintenance tasks.
6. The adequacy of indoctrination of all personnel regarding the potential hazards within the work area.

The primary function of AO's is that of keeping aircraft in top operating condition and providing the various weapons that can be used by supported aircraft to achieve a high degree of readiness for prompt and sustained combat operations.

Accident prevention is affected more by the quality of professional competence demonstrated by key individuals than by any other consideration. The close personal attention of maintenance supervisors is required.

The concept of aircraft maintenance safety should extend beyond concern for injury to personnel and damage to equipment and aircraft. Safe work habits go hand-in-hand with flying safety. Tools left in aircraft, improper torquing of fasteners, and poor housekeeping around aircraft can cause conditions which may claim the lives of flying personnel as well as cause strike damage to aircraft. Safety on the ground is equally as important as safety in the air.

A recent type commander letter states in part, "While the increased complexity of our modern aircraft is a factor, it is noted that a large number of maintenance-error-caused accidents and incidents are due, not to complexity of equipment, but to lack of supervision and technical knowledge. Many mistakes are simple ones in routine maintenance."

Safety in aircraft maintenance depends largely upon the supervisory personnel. The standards of quality which they establish are directly reflected in the quality of the aircraft maintenance. The primary duty of the senior petty officers is to supervise and instruct others rather than to become totally engrossed in actual production. Attempts to perform both functions invariably result in inadequate supervision and greater chance of error. Supervisors must exercise mature judgment when assigning personnel to maintenance jobs. Consideration must be given to each man's experience, training, and ability.

Sometimes overlooked in a maintenance program are the considerations generally grouped under the term "human factors." These factors are important in that they determine if an individual is ready and physically able to do work safely and with quality. Supervisory personnel should be constantly aware of conditions such as general health, physical and mental fatigue, unit and individual morale, training and experience levels of personnel, and other conditions which can contribute in varying degrees to unsafe work. Not only is it important that proper tools and protective clothing and equipment are available for use, but also the insistence by maintenance supervisors that they are used is of increasing importance with modern high performance aircraft. For example, maintenance personnel are sometimes negligent in the wearing of protective hearing devices in high noise areas.

Technical knowledge also plays a large part in a good maintenance safety program. The complexity of our modern equipment demands the attention of well-informed and expert maintenance personnel; otherwise, our weapons systems cannot be operated and maintained. Technical knowledge is a function of education and training which, incidentally, does not end with graduation from Class A school. Graduation is only the beginning. Any AO worthy of the rating is continually training and learning through self-study and application and through a personal desire for proficiency and self-betterment. But technical knowledge by itself is not sufficient unless it is coupled with an old-fashioned craftmanship that receives gratification and keen satisfaction in doing any job well. The AO who wishes to contribute to safety and reliability improvement must know his job and must develop professional pride in the quality of his work.

It is a continuing duty of every person connected with aircraft maintenance to try to discover and eliminate unsafe work practices. Accidents which are caused by such practices may not take place until a much later date and their severity cannot be predicted. The consequences may range from simple material failure to a major accident resulting in serious injuries or fatalities.

There are several areas in which the supervisor can effectively work to minimize accidents. The organization and administration of an active and continuous program of accident prevention with provisions for inspection of work areas, tools, and equipment; correct interpretation and dissemination of safety directives and precautions; and energetic and imaginative enforcement of them are all important.

ORGANIZATION AND ADMINISTRATION OF AN ACTIVE PROGRAM

It is the responsibility of all supervisory personnel to insure that their subordinates are instructed in and carry out the applicable safety precautions for their area of work. Each individual is held responsible for knowing, understanding, and observing all safety precautions applicable to their work and work areas. The individual is additionally charged with the following responsibilities:

1. The individual should report to work reasonably rested and emotionally prepared to perform the tasks at hand.
2. He should exercise normal prudence in all his functions, commensurate with the work at hand.
3. He should report all unsafe conditions regarding equipment and materials and any unusual or developing hazards to his immediate supervisor for appropriate action.
4. He should warn others whom he believes to be endangered by known or potential hazards and of their failure to observe safety precautions.
5. He should report to his supervisor any accident, incident, injury, or evidence of potential hazard occurring in the course of work.
6. He should wear or use the protective clothing and/or equipment of the type approved, required, and provided for the safe performance of his work.
7. He should report for work suitably attired for his assigned tasks. For example, wear eye correction, hearing aid, foot protection, style of clothing, hair style, beard, etc., as applicable, that would not present a hazard.

The safety program must be in accordance with local instructions and instructions provided in OpNav Instruction 4790.2 for the maintenance department/division safety program. The Navy Aircraft Accident, Incident, and Ground Accident Reporting Procedures provided in OpNav Instruction 3750.6 (Series) require maintenance personnel participation in investigating, reporting, and preventing aircraft accidents/incidents.

NavMat Publication P-5100, Safety Precautions for Shore Activities, contains precautions that cover almost all aspects of maintenance safety that are to be implemented by maintenance personnel. Mandatory precautions in this manual are characterized by use of the words shall, must, and prohibited. Recommended or advisory precautions are indicated by use of the words should, will, and may. The precautions are of necessity basic and general in nature and are not inclusive of all conceivable operations and functions involved in the large variety of Navy day-to-day activities. Reference is made from time to time to other publications for detailed safety information applicable to a specific condition or hazard. A lack of documented hazard with accompanying precautions is not an indication of their nonexistence or unimportance. Maintenance personnel must display continuous cooperation and vigilance in seeing that all operating procedures and work methods do not unnecessarily expose personnel to injury or property to loss or damage.

The NATOPS program provides complete and detailed guidance on procedures and precautions to be followed when operating naval aircraft. General guidance of concern to supervising petty officers may be found in ordnance publications, NATOPS Manual, General Flight and Operating Instructions, and the CVA/CVS NATOPS Manual. Ground and flight procedures for individual aircraft are contained in the NATOPS Manual for each specific aircraft.

The ground procedures will in most cases parallel those found in the General Information and Servicing volume of the Maintenance Instructions Manual for the specific aircraft concerned.

Instructions in appropriate safety precautions are required to be given and positive action must be taken in the case of willful violations.

The safety program will generally involve three areas of attention—the posting of the most important safety precautions in appropriate places, the incorporation of safety lessons in the formal training program, and frequent checks for understanding and compliance during the day-to-day supervision of work.

Fixed posters and signs must be placed in locations where personnel are most likely to see them and where they will provide the maximum impact. They should be relevant to activities engaged in by personnel located in the space where they are displayed and removed or rotated to enhance their effectiveness. Visual information should be presented in a positive manner so that it will impart appropriate precautionary measures without instilling fear. Appropriate safety posters may be obtained from the activity safety officer.

Posted safety precautions are more effective if they are easily complied with. For example, a sign on a tool grinder reads "goggles required," so one or more pairs of safety goggles should be hanging within reach at the machine. Similarly, the protective clothing poster in the welding shop should be backed up with readily available aprons, gloves, shields, etc.

The formal safety training sessions should utilize films, books, visual aids, or any other suitable technical material. The men should be told more than just what or what not to do. Each safety subject should be explained in detail. The results of unsafe acts are usually the most dramatic and easiest remembered. Causes of accidents and contributing factors should be reviewed and analyzed. Many good ideas for accident prevention have been developed in training sessions.

An extensive series of lessons may be developed over a period of time as latent hazards are recognized, and this will aid in keeping the sessions interesting while avoiding too frequent repetition.

It may be well to mention the new man in the work center at this point. A separate safety indoctrination lesson which covers all the major hazards of the work center should be given the new man as soon as he reports for work. No supervisor with an effective safety program and an excellent work center safety record wants to take the chance that the new man will be injured before attending the complete series of safety lessons.

In the third area of safety program administration-followup—the supervisor will have one or more key members of the work center who attend the quality assurance safety meetings. These members will provide inputs regarding safety violations and potential hazards that should be advertised and disseminate information discussed during meetings to all personnel in their respective work area. These members as well as supervisors provide a definitive communication link in pointing out peculiar activity hazards and current violations and can take immediate action to remedy such situations. Subordinate petty officers must assist in monitoring the program on a continuous basis. Also included in the followup area is a responsibility of the supervisor to inquire as quickly and thoroughly as possible into circumstances of accidents and reports of unsafe practices and the taking of action and/or making of recommendations.

Interpretation of Safety Directives and Precautions

The safety precautions contained in Safety Precautions for Shore Activities are designed to cover usual conditions ashore. Commanding officers and others in authority are authorized to issue special precautions to their commands to cover local conditions and unusual circumstances. The supervisor will have to apply both sets of rules in the administration of his work center safety program.

Safety directives and precautions should be followed to the letter in their specific application. Should any occasion arise in which any doubt exists as to the application of a particular directive or precaution, the measures to be taken are those which will achieve maximum safety.

When new safety posters or precautions are posted, it is the responsibility of the supervisor to correctly interpret their application to his men. In this way he will be able to achieve a unity of thought and action in the observance of the required safety rule.

The organization's safety officer is available to assist in interpreting and suggesting ways of implementing various safety directives and precautions. Current directives require that a safety officer or safety engineer be assigned as head of the safety department, division, branch, or section, whichever is applicable, at all shore stations.

In most instances the hazards involved and the applicable precautions for a given type of work are the same whether the work is done afloat or ashore. However, the safety program must account for inherent dangers and provide precautions necessary for afloat operations that are not present ashore. An example of this would be a hazard peculiar to flight deck operations or handling of ammunition.

INSPECTING FOR HAZARDOUS CONDITIONS

The armament supervisor should diligently inspect all work areas, tools, and equipment to detect potentially hazardous or unsafe conditions and take appropriate corrective action. The AO may be working in the hangar, line, stowage or assembly areas, or arming and dearming areas, and all these areas should be included in the supervisor's inspection. He should check for explosion or inhalation hazards due to improper ventilation of working spaces or careless handling of materials.

Fire hazards present another serious problem. "No Smoking" rules should be strictly enforced. Spilled oil, grease, and chemicals should be wiped up promptly, and all rags used should be disposed of in covered metal containers.

Handtools should be in good shape, of the proper type, and used only for the purpose for which they were designed.

Arming and Dearming Areas

The AO supervising arming and dearming ashore should carefully inspect the area prior to the arrival of the aircraft to detect any unusual conditions which are potentially hazardous. Rags or other items which may be ingested by aircraft engines should not be carried by the arming crew. Sound attenuators must be worn to prevent hearing loss, and, aboard ship, protective goggles and helmets must also be worn while on the flight deck during flight operations.

The danger of jet intakes and exhausts, or propellers is always present in these areas, and arming and dearming crews should be reminded of these hazards prior to each operation.

Stowage Areas

Stowage areas should be scrupulously inspected for any condition which might be detrimental to the material stowed therein. In ammunition stowage areas the following items should be inspected:

1. Doors secured against unauthorized entry.
2. Firefighting equipment in place and in serviceable condition.
3. Firebreaks are properly maintained and free of combustible material.
4. Ammunition is neatly stacked on dunnage and such stacks are stable and not in excess of the height permitted by NavOrd OP 5, Volumes 1 and 3 (latest revision).
5. Loose rounds, paints, oils, waste, or any other unauthorized materials are not present.
6. Grounding connections to the dunnage, and within stacks, where necessary, are in place.
7. Area is dry, properly ventilated, and free of abnormal odors.
8. Thermometers are in place and intact and readings made and recorded.

The above listing is by no means all inclusive. Personnel whose duties include inspection of ammunition stowage areas of any type should familiarize themselves with the contents of NavOrd OP 5, (latest revision).

Assembly Areas

Regardless of the type of ammunition components being assembled, the assembly area should meet the following general safety precautions:

1. The area must be approved for the operation to be performed.
2. The number of persons involved must be held to the minimum required to safely accomplish the task.
3. Explosive limits for the area must be understood and adhered to.
4. All safety devices and equipment must be maintained in a fully operable condition.
5. Equipment use and assembly procedures should be thoroughly understood before starting.
6. All assembly procedures should be performed carefully, methodically, and without undue haste.

Tools and equipment play an important part in any assembly operation. When maintained in good condition they assist in the performance of a safe and efficient job.

Cleanliness and good housekeeping in all working areas are major factors in effective accident prevention. Tools and equipment should always be returned to their proper stowage places after use. Solvents, grease, rags, and any other cleaning or lubricating agents should be removed from assembly areas immediately upon completing the task at hand.

Weapons System Emergency Procedures

Safety precautions peculiar to a specific aircraft are covered to a large extent in the General Information volume of the Maintenance Instructions Manual for that aircraft. The emergency procedures section of this manual is a most useful aid when producing safety training lectures for formal presentation. While it pertains primarily to line personnel, crash rescue personnel, and plane captains, the information could prove invaluable for that moment when a tailpipe fire, brake fire, nose gear collapse, or similar incident occurs in the absence of personnel trained to handle such emergencies and immediate action is required. As the senior person present, you would be expected to take charge and initiate this action.

The warnings and precautions dispersed throughout the various maintenance manuals and included in most other directives must be adhered to. Changes or revisions to manuals should be screened upon receipt for new procedures, warnings, precautions, etc., that may affect your area of work and that may require amplification or clarification.

CERTIFICATION PROGRAM

The Conventional Aviation Ordnance Qualification and Certification Program as outlined in OpNav Instruction 3571.3 (Series) requires all personnel working with or handling aviation ordnance to be qualified and certified or in training for the program (trainees must be under the supervision of a qualified and certified individual).

The certification program was established after numerous accidents occurred due to personnel handling ammunition and explosive devices in a rough or unauthorized manner. The program is effective only as long as the senior petty officers and officers responsible for its administration insure that the intent of the program is disseminated and enforced. All personnel that assemble, handle, or in any way have contact with explosives or explosive devices are to be certified or under the direct supervision of a qualified and certified person.

Personnel may be qualified by attending and successfully passing a formal course of instruction on specific items or through on the job training by the command. Personnel may be certified only after they have qualified and have been nominated by their division officer to the certification board. The certification board will assign a board member to observe the individual performing each specific task for which he has been nominated for certification. After a certification board member observes an individual, he reports his findings to the senior member of the certification board. After reviewing the individual's service record and health record (medical department), the board then must decide if the individual is mentally and physically fit and has sufficient knowledge (in the specific areas for which he was nominated for certification) to safely work with explosives.

The findings (certified or not certified) are forwarded to the personnel officer for inclusion in the individual's service record on page 13. The personnel officer will have the certification information entered and then sign the form (indicating that the entry has been made) and return it to the certification board. The certification board then forwards the form to the individual's division officer who in turn has the information recorded in the individual's training folder.

Each individual task/job for which an individual is certified is valid for 1 year. Each team task/job for which an individual is certified is valid for 1 year or until the team crew leader is replaced or any team member's certification expires, whichever occurs first. Recertification requires the same procedures as the initial certification. Blanket type certifications only void the useful intent of the program. Each task/job in which a man is certified must be backed with records in the individual's training folder.

Certification Board

The certification board is composed of no less than three members, all of whom must have had at least 6 years experience in aviation ordnance, E-6 or higher, and exhibit a high level of technical competence and leadership. Each board member must be designated in writing by the commanding officer.

Certification Revoked

Individuals that become unreliable (i.e., alcoholism, mentally unstable, indebtedness, continued violations of the UCMJ, or any reason that the division officer deems will cause the man to perform in a careless or unsafe manner) are removed from the certification program.

When an individual has been removed from the certification program, the senior member is responsible for initiating the action to provide this information to the personnel officer who in turn will insure that this information is recorded on page 13 of the individual's service record.

TRAINING OF PERSONNEL

The proper training of armament maintenance personnel is a necessity, and is an important responsibility of the senior AO. An inspection of a well-run, efficient, shop would undoubtedly reveal a flexible training program, with competent instructors. The competent instructor should utilize each opportunity to instruct less skilled AO personnel in the varied tasks that may be assigned. This training may be accomplished by many methods such as lectures, movies, training aids, group discussions, on-the-job training, etc. Due to limited facilities, however, most maintenance training at the ordnance shop level is either by the lecture method or on-the-job training method.

Navy training schools, factory training, and in-service training are available for the training of maintenance personnel. The class A and B schools provide the necessary prerequisites for the specialized supplementary training provided on specific aircraft, equipment, groups of related equipment, or specialized techniques (maintenance management) by the various NAMTraDet's.

Even if a supervisor is fortunate enough to have a group of men who are highly skilled and well trained, he will find that training is still necessary. For example, the training of strikers and lower rated men for advancement examinations is a continuing, never-ending process. The Navy rotation policy being what it is, the best men will eventually be transferred and replacements will be received aboard. The replacements will, in most instances, require training before they can be relied on to take their places as effective members of the shop organization. These and similar problems require the ordnance supervisor to be well versed in the several aspects of training—able to set up as well as conduct an effective inservice training program for assigned personnel.

ORGANIZING THE TRAINING PROGRAM

Organizing a training program involves such considerations as planning lessons and job plans, selecting and qualifying instructors, making arrangements for classroom space, phasing the training program with the scheduled workload, procuring visual and other training aids, and determining teaching methods for each lesson or lesson series.

The subject matter areas to be included in the training program are (1) material relating to maintenance of weapons release systems and ammunition assembly, handling, and stowage; (2) general material required by the men for advancement in rating examinations; and (3) material relating to safety. In most cases lessons will fall under more than one of the subject areas.

Once it has been determined what publications will adequately cover the subject areas, the material must be divided into lessons, and lesson guides prepared. The lesson guides for each lecture are prepared in accordance with the standard format provided in OpNav Instruction 4790.2 (Series). The lectures are numbered to provide a means of recording each man's progress within his individual training folder. A training syllabus, similar to the one illustrated in figure 2-1, is prepared for each man in the work center and provides a handy index to the state of training of the work center personnel as a whole.

Whether the supervisor teaches the lessons himself or assigns other petty officers to conduct them depends on the state of training of his first and second class petty officers. A requirement for advancement for third class petty officers and nonrated personnel is satisfactory completion of the correspondence course based on Military Requirements for Petty Officer 3 & 2, NavPers 10056 (Series). This text book sets forth some of the basic principles of training in general and teaching in particular.

An advancement requirement for second and first class petty officers is satisfactory completion of the correspondence course based on Military Requirements for Petty Officer 1 & C, NavPers 10057 (Series). The latter text expands and amplifies training theory and introduces job analyses, training aids, and testing. For the first time in his career the prospective First Class Aviation Ordnanceman is required to demonstrate his ability to formally teach, use various training aids, and prepare and administer written tests. In order to demonstrate correct instructional techniques the supervisor may elect to teach certain lessons himself or assign them to a competent instructor for the same purpose. Later he may assign less proficient petty officers as instructors so that they may acquire the experience necessary for completing their practical factors for advancement.

If at all possible, training sessions should be conducted at the same time of day and on a regular schedule. Training must be scheduled to encompass all working shifts so that all personnel are included in the overall training program. Factors to consider when scheduling lessons are usual flight schedule, meal hours, watches, and availability of classroom.

Some lessons are better suited for one type of instructional technique than others. The type of presentation for each lesson should be planned in advance. This will also facilitate the rotation of the lessons among the petty officers who require experience in teaching.

The effectivity of aviation technical training is greatly enhanced by the use of training aids. The supervisor should always be on the alert for scrap material that can be converted to training aids with minimum expense. (Remember, never attempt to disarm live ordnance for any reason. Inert ammunition is available for instructional purposes.) He must be aware of the existence of applicable training films and, if they are available, schedule them for showing in conjunction with specific lessons. The squadron or unit safety officer or station safety engineer may usually be depended on to supply training aids in support of shop safety presentations.

When planning a training program, the supervisor should decide where the classroom sessions should be conducted. The space selected should preferably be in a quiet area or at least one with a minimum of noisy distractions. The area should be large enough to accommodate the expected student load and be well lighted. Adequate ventilation will help keep the men awake and interested in the presentation. Convenience is another factor in the selection of classroom space. Some of the desirable space characteristics may, on occasion, have to be sacrificed in order to find a classroom nearer to the working area.

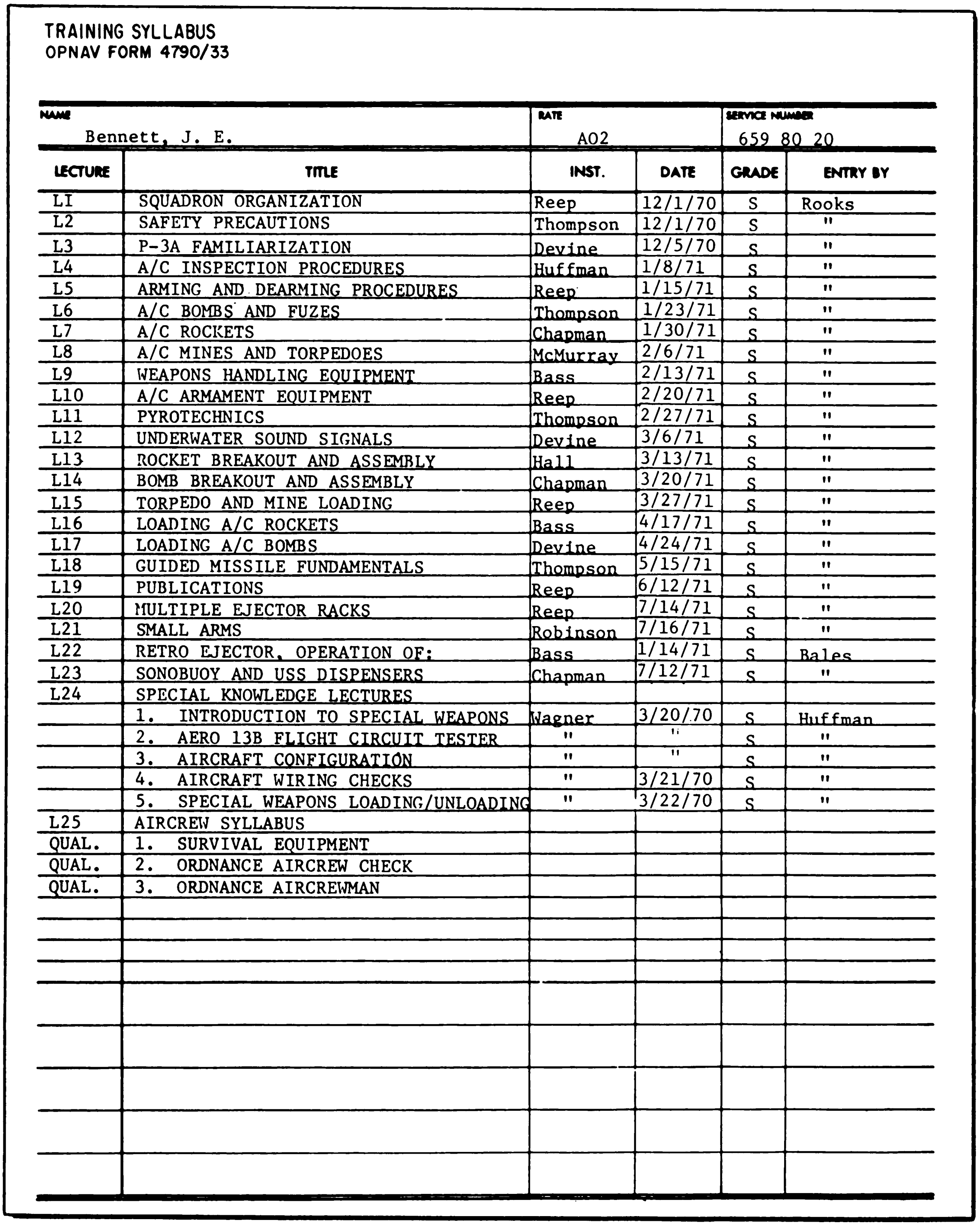
TRAINING PROCEDURES

Inservice training represents a major contribution to the Navy's overall training program. To satisfy the individual activity's particular requirements, the training program must include both lectures and practical training. In this respect, training procedures are of two general types—formal and informal.

Formal Inservice

Formal inservice training is conducted in the classroom through lectures, supplemented by required reading and implemented by the use of all available visual aids. A schedule of training is prepared and published by the maintenance administration officer (G Division officer aboard carriers). This schedule is usually prepared on a monthly basis and lists the subject of the lesson or its identifying syllabus number, the time that the training is to take place, the location of the classroom, the names of the men who are to attend, and the name of the instructor.

Lesson guides are prepared by designated officers, petty officers, and in some instances



TRAINING SYLLABUS
OPNAV FORM 4790/33

NAME	RATE	SERVICE NUMBER
Bennett, J. E.	AO2	659 80 20

LECTURE	TITLE	INST.	DATE	GRADE	ENTRY BY
LI	SQUADRON ORGANIZATION	Reep	12/1/70	S	Rooks
L2	SAFETY PRECAUTIONS	Thompson	12/1/70	S	"
L3	P-3A FAMILIARIZATION	Devine	12/5/70	S	"
L4	A/C INSPECTION PROCEDURES	Huffman	1/8/71	S	"
L5	ARMING AND DEARMING PROCEDURES	Reep	1/15/71	S	"
L6	A/C BOMBS AND FUZES	Thompson	1/23/71	S	"
L7	A/C ROCKETS	Chapman	1/30/71	S	"
L8	A/C MINES AND TORPEDOES	McMurray	2/6/71	S	"
L9	WEAPONS HANDLING EQUIPMENT	Bass	2/13/71	S	"
L10	A/C ARMAMENT EQUIPMENT	Reep	2/20/71	S	"
L11	PYROTECHNICS	Thompson	2/27/71	S	"
L12	UNDERWATER SOUND SIGNALS	Devine	3/6/71	S	"
L13	ROCKET BREAKOUT AND ASSEMBLY	Hall	3/13/71	S	"
L14	BOMB BREAKOUT AND ASSEMBLY	Chapman	3/20/71	S	"
L15	TORPEDO AND MINE LOADING	Reep	3/27/71	S	"
L16	LOADING A/C ROCKETS	Bass	4/17/71	S	"
L17	LOADING A/C BOMBS	Devine	4/24/71	S	"
L18	GUIDED MISSILE FUNDAMENTALS	Thompson	5/15/71	S	"
L19	PUBLICATIONS	Reep	6/12/71	S	"
L20	MULTIPLE EJECTOR RACKS	Reep	7/14/71	S	"
L21	SMALL ARMS	Robinson	7/16/71	S	"
L22	RETRO EJECTOR, OPERATION OF:	Bass	1/14/71	S	Bales
L23	SONOBUOY AND USS DISPENSERS	Chapman	7/12/71	S	"
L24	SPECIAL KNOWLEDGE LECTURES				
	1. INTRODUCTION TO SPECIAL WEAPONS	Wagner	3/20/70	S	Huffman
	2. AERO 13B FLIGHT CIRCUIT TESTER	"	"	S	"
	3. AIRCRAFT CONFIGURATION	"	"	S	"
	4. AIRCRAFT WIRING CHECKS	"	3/21/70	S	"
	5. SPECIAL WEAPONS LOADING/UNLOADING	"	3/22/70	S	"
L25	AIRCREW SYLLABUS				
QUAL.	1. SURVIVAL EQUIPMENT				
QUAL.	2. ORDNANCE AIRCREW CHECK				
QUAL.	3. ORDNANCE AIRCREWMAN				

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Figure 2-1.—Training syllabus.

by Contractor Engineering Technical Services/ Navy Engineering Technical Services personnel. The lesson guides should contain the lecture number, title, date prepared and by whom, objectives of the lesson, time normally required in presenting the lesson, list of instructional aids, list of references with which the instructor should become familiar before teaching the lesson, outline for presentation, summary of the lesson, and questions and answers to check for understanding.

When a petty officer has been assigned to instruct a given lesson, it is his responsibility to procure a copy of the lesson guide and from it prepare his personalized lesson plan. Since lesson plans are prepared by the individual instructor, they may differ slightly from instructor to instructor. They must cover the information outlined in the lesson guide. The quality of the lesson given will reflect the amount of preparation given by the instructor plus his experience and ability to instruct.

Informal Inservice

Informal training is the practical instruction of men in the performance of maintenance tasks by means of demonstration and imitation under personal supervision in the shop or on the operating line. Nearly every maintenance task that is undertaken presents an opportunity for on-the-job training. The experienced men of the work center are utilized as fully as possible in demonstrating and imparting their skills to the less experienced.

Under this system, the trainee has the opportunity to actually do the job under the supervision of an experienced petty officer. The only equipment necessary is the job itself. It is necessary, of course, that the instructor have an interest in the job and the skill to do it well. The striker or trainee will learn by seeing the job performed, and he will gain experience by having a chance to participate in the accomplishment of the job.

The nature of informal training makes regular scheduling impracticable. Actually, it is done at every opportunity. A training syllabus is prepared under the guidance of the maintenance officer, with content and scope corresponding with practical factor requirements of the personnel. The degree of success in on-the-job training (OJT) depends on the degree of recognition by each individual of his responsibility to his outfit to impart his skill and knowledge to the man who is trying to learn.

TRAINING DOCUMENTATION AND RECORDKEEPING

Maintenance activities, except those that are specifically excluded, should comply with the manhour accounting procedures outlined in OpNav Instruction 4790.2 by submitting manhour accounting cards to reflect the accomplishment of formal inservice training. Procedures for submitting manhour accounting cards are provided in Military Requirements for Petty Officer 3 & 2, NavPers 10056 (Series) and OpNav Instruction 4790.2.

The individual Training Syllabus Sheet provides a record of formal lectures attended by each man in the work center. A report of practical training (OJT) should be made to the division officer at regular intervals. This will indicate to the division officer that a man has fulfilled a satisfactory level of skill to justify completing of the various items listed on the individual's practical factors for advancement sheet and the Aviation Ordnance Certification Program. The formal training syllabus record and the record of practical training will indicate that required training has been completed in all areas or that a need for special training exists and further certifies when the individual may be considered qualified for advancement.

REQUIRED READING AND MAINTENANCE INFORMATION RECORD

Certain directives and publications are routed to the various work centers as maintenance information, and copies of such maintenance information must be disseminated and retained until it is no longer applicable. Information should be placed in a required reading file that is available to all hands in the work center. When new material is received, it is placed in the "active" required reading file until it is read and initialed by each man in the work center. It may be necessary for the work center supervisor to amplify or clarify some information so that it will be properly understood.

Once all personnel in the work center have read and initialed the material, it is placed in the "standing" required reading file for use in indoctrinating new personnel and for periodic review by those personnel who may require it. Newly assigned personnel should read and initial both the active and standing file. If copies of directives or publications are not available for the required reading file, a cross-reference sheet indicating the general content of the subject matter and its location is utilized to insure that personnel are thoroughly aware of all information that could affect their actions.

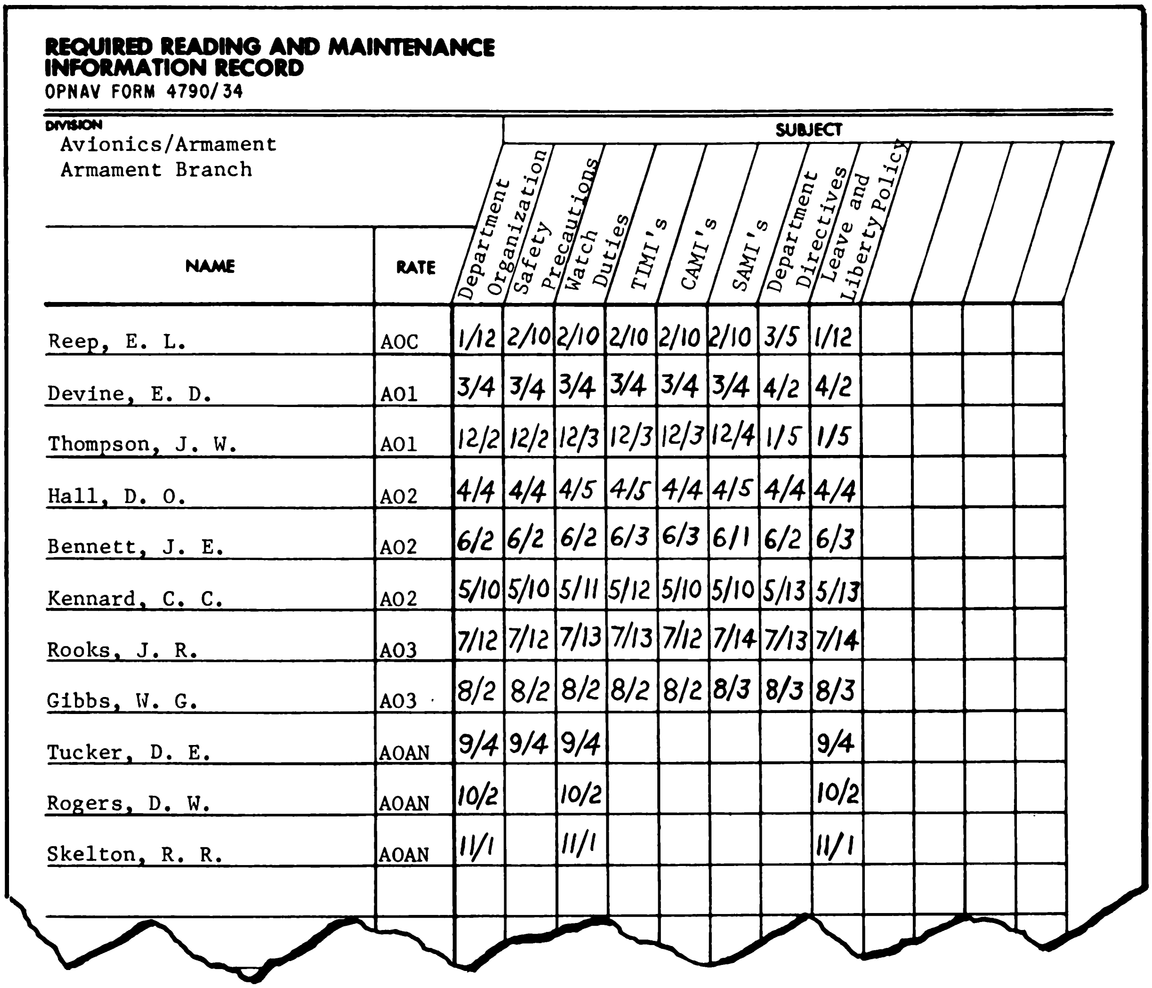
OpNav Form 4790/34 (fig. 2-2) or its equivalent is used to maintain records on required reading.

TRAINING SCHOOLS

Naval schools and courses are maintained to assist forces afloat by providing training that is not available at the local level. New men reporting to a command who are a graduate of a service school or course will not require as much training as a nonschool graduate to become a useful member of a fighting team. Senior AO's are responsible for insuring that each man is adequately trained to perform assigned tasks/jobs. With planning, a supervisor can schedule his personnel to the various schools and courses available to aid him in complying with mandatory requirements for having school graduates perform certain jobs.

Classes of Schools

The Naval Air Technical Training Command, with headquarters at Naval Air Station Memphis, Millington, Tennessee, has numerous activities where intensive training is conducted in several categories. Detailed information for obtaining school quotas is contained in Navy Formal Schools Catalogs (CNT P1550/1.)



REQUIRED READING AND MAINTENANCE INFORMATION RECORD
OPNAV FORM 4790/34

DIVISION
Avionics/Armament
Armament Branch

SUBJECT

NAME	RATE	Department Organization	Safety Precautions	Watch Duties	TIMI's	CAMI's	SAMI's	Department Directives	Leave and Liberty Policy				
Reep, E. L.	AOC	1/12	2/10	2/10	2/10	2/10	2/10	3/5	1/12				
Devine, E. D.	AO1	3/4	3/4	3/4	3/4	3/4	3/4	4/2	4/2				
Thompson, J. W.	AO1	12/2	12/2	12/3	12/3	12/3	12/4	1/5	1/5				
Hall, D. O.	AO2	4/4	4/4	4/5	4/5	4/4	4/5	4/4	4/4				
Bennett, J. E.	AO2	6/2	6/2	6/2	6/3	6/3	6/1	6/2	6/3				
Kennard, C. C.	AO2	5/10	5/10	5/11	5/12	5/10	5/10	5/13	5/13				
Rooks, J. R.	AO3	7/12	7/12	7/13	7/13	7/12	7/14	7/13	7/14				
Gibbs, W. G.	AO3	8/2	8/2	8/2	8/2	8/2	8/3	8/3	8/3				
Tucker, D. E.	AOAN	9/4	9/4	9/4					9/4				
Rogers, D. W.	AOAN	10/2		10/2					10/2				
Skelton, R. R.	AOAN	11/1		11/1					11/1				

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Figure 2-2.—Required reading and maintenance information.

CLASS P.—Class P schools/courses are designed to provide training at a preparatory level for group IX (aviation) ratings, and to provide nonrated aviation personnel with the information and practical training necessary to complete the qualifications for advancement to airmen.

CLASS A.—Class A schools/courses are generally limited to providing those prerequisites necessary to prepare trainees for specialized training which is offered by Naval Aviation Maintenance Training Detachments and Fleet Airborne Electronic Training Units and to provide instruction to qualify personnel to perform duties appropriate to a nonrated individual.

CLASS B.—This advanced training is designed for personnel in a career status and provides aviation technical training for rated personnel to supply the fleet with highly qualified men.

CLASS C.—These schools/courses are designed to provide training on specific equipment and/or systems, or in particular skills and techniques.

CLASS O.—These schools/courses are conducted for officer personnel and provide training to meet the needs of naval aviation.

NAVAL AIR MAINTENANCE TRAINING GROUP.—This group, within the Naval Air Technical Training Command, provides on-site training for officers and enlisted personnel in the operation, maintenance, and repair of aeronautical weapon systems and associated equipment using NAMT's (Naval Air Maintenance Trainers). NAMT's are instructional units which provide training support for a weapon system, a specific equipment, groups of related equipment, or specialized techniques. Further information is contained in the Navy Formal Schools Catalog, CNT P1550/1.

Other Technical Training

Other courses available to personnel on specific types of equipment or systems are discussed in the following sections.

FAETU (FLEET AIRBORNE ELECTRONIC TRAINING UNIT).—The FAETU's are charged with the instruction of Fleet personnel in courses covering operational and tactical employment of specific equipment and systems. Information regarding availability of courses is contained in the ComNavAirLant/ComNavAirPac 1500 Series Instructions.

AIR RESERVE TRAINING COMMAND ASW TACTICAL SCHOOL EAST/WEST.—These schools are primarily charged with the instruction of reserve personnel in courses covering operational and tactical employment as well as maintenance of specific equipments and systems. Information regarding availability of courses is to be found in the Navy Formal Schools Catalog, CNT P1550/1.

NAVAL AIR REWORK FACILITIES.—To meet the increasing need for highly trained technicians in the maintenance of modern aeronautical weapon systems, it has been necessary to provide certain specialized training for military personnel at the NavAiReWorkFac's. This training is not intended to duplicate any present courses of instruction provided by the NAMTraDet's or FAETU's, but is intended to supplement the other training courses. Most courses are of short duration and emphasize troubleshooting, alinement, specialized training, and bench work on various accessories and components. The NavAirSysComRepLant/Pac/Pncla periodically provide course catalogs or course listings to fleet and shore activities so that they may be aware of this service. The NavAiReWorkFac's conduct courses requested by fleet and shore activities on an on-call basis in accordance with instructions from the cognizant NavAirSysComRep. These courses are tailored to the operational requirements of the fleet and the Training Commands and are listed in NavAirRepLant/Pac/Pncla Instruction 1500.2 (Series).

AVIATION READINESS TRAINING.—The type commanders have implemented aviation readiness training procedures on specific aeronautical weapon systems for aviation ground officers and key enlisted maintenance personnel. Training is conducted by the Naval Air Maintenance Training Group and their various detachments, Fleet Air Electronics Training Units, and Readiness Training Squadrons in accordance with syllabuses approved by the type commanders. Detailed procedures for the various types of weapon systems, equipments, and missions may be found in instructions promulgated by the type commanders. Enlisted maintenance personnel receive NAMTraDet/FAETU training courses in familiarization, operation, and/or maintenance of the specific weapon system or equipment which they will be required to maintain. In addition, the Readiness Training Squadrons provide in-service training, and those personnel who successfully complete the training course are awarded the appropriate NEC.

INTER SERVICE TRAINING.—The Department of Defense and the other services conduct schools/courses which are available to Navy personnel. These schools/courses should be checked prior to requesting factory training.

CONTRACTOR ENGINEERING AND TECHNICAL SERVICES.—Contractor plant services and contractor field services training are provided by NavAirSysCom on new weapon systems being introduced to the fleet. A nucleus of personnel is trained by the contractor either at his facility or on-site. The type of personnel ordered to this specialized training program must be of the highest caliber and capable of instructing other personnel upon completion of the training.

TECHNICAL DATA

Technical data are provided in numerous forms for training, operations, maintenance, calibration, repair, storage, and shipment of weapons systems and equipment. These data are important elements of the logistics support necessary for the insurance of fleet readiness and equipment availability. Personnel training, operation, and maintenance of today's sophisticated, high-performance weapons systems demand the development and dissemination of accurate, clear, and concise technical information. Investigation proves that a worker's ability to support and maintain modern equipment is directly related to the quality of the documentation and the training program established therefor.

Technical data are recorded information used to define a design and to produce, support, maintain, or operate items of defense material. These data may be recorded graphic or pictorial delineations in media such as technical manuals, drawings, or photographs; text in specifications, related performance, or design type documents; and machine forms such as punched cards, magnetic tape, or computer memory printouts that may be retained in computer memory.

Technical documentation is recorded technical data. The methods used to record data for technical documentation are microfilm, technical directives, tapes, manuals, etc.

The AO supervisor is responsible for having a knowledge of the various types of technical data that are available to aid him in training and meeting the operational commitments of the command.

An understanding of the information listed in the following manuals is assumed and will not be repeated in this manual:

Military Requirements for Petty Officer 3 and 2, NavPers 10056-C.

Military Requirements for Petty Officer 1 and C, NavPers 10057-C.

Aviation Ordnanceman 3 and 2, NavPers 10345-C.

TYPES OF TECHNICAL DATA

Technical data are presented in varied forms; however, data available to fleet and repair activities fall into three major categories: technical manuals, technical directives, and engineering drawings and associated data.

Technical Manuals

To attain a satisfactory state of readiness, technical manuals are developed, published, and distributed concurrently with hardware. Periodic changes and revisions are issued as necessary to insure that manuals continually reflect equipment configuration and current operational and support concepts and procedures. Technical manuals released under the authority of ComNavAirSysCom are considered the only authorized source of the information provided and the instructions contained therein are mandatory.

Technical Directives

For rapid documentation of weapons systems or equipment change information, for citing of special inspection requirements, or for clarifying or emphasizing operational or maintenance parameters, NavAirSysCom issues information through the technical directive system.

Engineering Drawings and Associated Data

This category of data is procured and issued in support of detailed maintenance and repair of weapons systems and equipment.

NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL POLICY

Command policy objectives are directed toward providing the most adequate and accurate technical manuals to support training, operations, and maintenance. Constant surveillance is maintained to permit timely state of the art improvement in the manual system and to accelerate information feedback to effect response corrective change, and revision action for timely delivery to using activities.

A complete technical data package is not required by each operating or support activity for effective logistic performance. Aviation activities, station maintenance divisions, and other nonindustrial units are normally provided all required technical data in the form of technical manuals and technical directives. Only industrial activities are normally provided engineering data in addition to manuals and directives.

Data are prepared for support of the five major areas of coverage defined as follows:

1. Operations. Technical manual data describing the operation of major weapons systems or equipment; i.e., in the case of aircraft, it describes the aircraft, its installed systems, handling and servicing requirements, operational limitations, etc.
2. Maintenance. Technical manual data, specialized test tapes, diagnostic information, and engineering data are designed to provide general and specific instructions required for performance of organizational, intermediate, and depot levels of maintenance and repair.
3. Training. Technical manuals provide for support of operational and maintenance training.
4. Configuration Modification. Data necessary for alteration or modification of systems or equipment are disseminated to using activities through the technical directives system. Concurrent changes to affected manuals are prepared and released through the manual distribution system to reflect the maintenance requirement for all system configuration.
5. Supply Support. Coordinated action between the NavAirSysCom, ASO, and SPCC provides supply documents, such as allowance lists and initial outfitting lists. Illustrated parts breakdown manuals are prepared and distributed for specific systems and equipment for identification and supply support of spare component and spare parts. PPB's (Provisioning Parts Breakdowns) and MEAR's (Maintenance Engineering Analysis Records) are also provided when required to support maintenance and/or technical logistics operations.

Types of Technical Manuals

Technical manuals are selected and prepared to cover general information as well as specific areas of equipment coverage. Every effort is made to insure that content of individual manuals (or sections thereof) are directed to specific work areas as well as maintenance levels. This eliminates unnecessary duplication and clearly presents the required information to the user. Some of the major types of manuals and typical examples are listed in the following paragraphs.

1. Operational Manuals are specifically prepared to define methods and procedures for conducting operational tasks or exercises. The following are examples of Operational Manuals:

NATOPS (Naval Air Training and Operating Procedures) Series are specifically prepared in support of aircrew personnel. The NATOPS provides standardized ground and flight operational procedures, training requirements, and other operational information of a technical nature. The data are tailored to ships and particular models of aircraft in accordance with CNO directives.

Special/Airborne Weapons/Stores Loading Manuals and Related/Nuclear/Conventional Check Lists are specifically prepared for use by squadron ordnance personnel. The manual series is under the technical direction of the Naval Weapons Evaluation Facility of Albuquerque, and is the only authorized source of information pertaining to preload and postload checks, loading and down loading of airborne special/conventional weapons and other stores, such as practice weapons, gun pods, tow target equipment, etc.

Tactical Manuals define aircraft operational parameters, weapons/stores clearances, and combat capabilities and limitations as authorized by CNO. The manuals are prepared under the technical cognizance of the Commander, Operational Test and Evaluation Force, and the information presented therein is mandatory.

2. Maintenance Instructions Manuals provide general and specific instructions concerning material description, principles of operation, and maintenance and repair data for the levels of maintenance authorized by the maintenance support plan. The manuals usually consist of a series of volumes numbered in the airframe series and are normally broken down by the assigned organizational and intermediate levels of maintenance.

3. Component and Equipment Manuals are separately selected manuals that normally provide component and equipment coverage through the intermediate and depot levels of maintenance.

These manuals usually support material installed in multiple equipment applications, and are identified by specially assigned category manual numbers; i.e., engines, avionics, armament, etc.

4. Work Unit Code Manuals provide a listing of assigned numeric codes for identification of installed systems or equipment. Discrepancies and maintenance actions are reported by code into the 3-M system. Reported information is entered on electronic data processing cards for processing statistical failure and usage reports. These reports are used as a management tool for the development and implementation of equipment design, maintenance, material, and supply improvements.

5. Periodic Maintenance Requirements Data are specifically designed to sequentially define periodic scheduled maintenance and inspection requirements. Examples of each are as follows:

The PMRM (Periodic Maintenance Requirements Manual) is designed for use as an air weapons system scheduled maintenance coordinating and planning document for all levels of maintenance. This series prescribes all scheduled and periodic maintenance for a given weapon system, including its subsystems, components, and ground support equipment.

Maintenance Requirements Cards define the minimum periodic maintenance requirements necessary for efficient and effective operation of a specific air weapon system, its installed equipment, and its ground support equipment. Information includes inspection tasks which verify the existence of correct conditions or isolate equipment discrepancies. Data related to proper clearances, tolerances, pressures, operating limits, parts replacement, and special tool requirements are also included.

6. GSE (Ground Support Equipment) Manuals define the correct procedures for the functional operation, maintenance, and servicing of GSE. When required, these manuals also include calibration of GSE.

7. IPB's (Illustrated Parts Breakdowns) provide system, subsystem, and individual parts identification and replacement source data. Coverage is normally contained in separate manuals or in a special section of the maintenance manual. Identification is enhanced by graphic display of exploded views and assembly breakdown of systems and equipment designated as replaceable or repairable. IPB's are issued for all aircraft, contractor/government furnished equipment components and equipment, related hardware, and GSE, for which bit and piece support is to be provided. Separate IPB's are not provided for those items of CFE (Contractor Furnished Equipment) for which complete breakdown is contained in the airframe IPB. IPB's do not identify supply data such as FSN's. Part number data must be cross referenced to NavSup cross reference catalogs to identify FSN's.

Technical Data Not Under NavAir SysCom Cognizance

Many other Navy publications not under the cognizance of NavAirSysCom are of interest and importance to the AO; for example, training manuals, correspondence courses, Safety Precautions, the Landing Party Manual, etc.

ARMY AND AIR FORCE PUBLICATIONS.—Other publications from which valuable information and instructions may be gained are Department of the Army publications and Air Force publications. Examples of these are such publications as Technical Manuals, Technical Bulletins, Field Manuals, Standard Nomenclature Lists, etc.

ORDNANCE PUBLICATIONS.—These were formerly prepared by the Bureau of Naval Weapons; and if printed prior to May 1966, they carry the NavWeps identification. They are now prepared by the Naval Ordnance Systems Command; or in some cases concerning airborne ordnance, they are prepared by the Naval Air Systems Command and are designated NavAir OP's.

NavOrd Ordnance Pamphlets (OP's) are basic publications, serially numbered without regard to subject content or date of publication, dealing with specific ordnance equipment, or subjects within the field of ordnance. Equipment OP's usually provide descriptive information and instructions necessary for the operation, service, and maintenance of specific ordnance equipment.

NavOrd Ordnance Data (OD's) are serially numbered in the same manner as OP's. They contain test, inspection, installation, description, maintenance, and operation data on components of ordnance equipment within the technical field. In the field of administration, OD's are published for publications allowance lists, equipment lists for specific ships, and the Index to Navy Ammunition Stock, OD 12067 (Series).

NavOrd letter type publications are published and distributed under the cognizance of NavOrd in the form of changes to OP's, OD's, NavOrd

Lists, etc. However, the main types of letter publication concerning AO's are the instructions and notices distributed by the Directive Issuance System.

In order to improve the availability and effectiveness of ordnance publications, NavOrdSysCom has established a system for updating of Ordnance Pamphlets (OP's) and Ordnance Data (OD's) on a periodic basis. Feedback from forces afloat, from training activities, and from maintenance activities is an essential element in keeping these technical manuals up to date.

TECHNICAL DIRECTIVES

The TD (Technical Directives) system is the authorized medium for directing the accomplishment and recording of modifications and one-time inspections of NavAirSysCom accepted equipment in either the contractor's or Navy's possession.

Types of Technical Directives

Technical directives are issued as formal (letter type) and interim (message type) directives. A formal TD is a document issued as a change, or as an amendment or revision thereto, and promulgated by letter. An interim TD is a document issued as a bulletin or change, or as an amendment or revision thereto, and promulgated by message to insure expeditious dissemination.

CHANGES.—A change is a document comprised of instructions and information which directs the accomplishment and recording of a material change, a repositioning, a modification, or an alteration in the characteristics of the equipment to which it applies.

BULLETINS.—A bulletin is an interim document, comprised of instructions and information, which direct an initial inspection to determine whether a given condition exists, and directs an interim revision to the TM series, if applicable, for continuing inspections. It specifies what action is to be taken if the condition is found or not found. Inspections may result in a need for corrective action requiring the use of approved repair procedures involving material in order to restore design integrity, as long as configuration control is not jeopardized.

AMENDMENTS.—An amendment is a document comprised of information which clarifies, corrects, adds to, deletes from, makes minor changes in requirements to, or cancels an existing TD. A maximum of three amendments may be applied to any TD, each remaining in effect until rescinded or superseded by a revision. Amendments may not be used to cancel an amendment.

REVISIONS.—A revision is a completely new edition of an existing change or bulletin. It supersedes the original directive or revision and all existing amendments.

INTERIM TECHNICAL DIRECTIVES.—ITD's (Interim Technical Directives) are technical documents used to direct the accomplishment and recording of modifications and one-time inspections of NavAirSysCom accepted equipment. They are promulgated by message.

TECHNICAL LIBRARY

The aeronautical technical library serves two important functions: First, it provides a central source of up-to-date information for the use of all technical personnel in the current performance of their work; and second, it is an excellent source of reference information to facilitate personnel training and individual improvement. To perform these functions properly, the technical library must contain at least one copy of all publications affecting assigned aircraft, ordnance, and related equipment, in accordance with the maintenance level responsibility involved. Initial outfitting allowances are sufficient to establish the technical library. However, additional copies of selected publications must be ordered for ready availability and use at the working levels.

Management of the technical library is a function of the QA Division (G Division is responsible for the AO technical library aboard carriers). This function includes the determination of technical manuals required to support the maintenance organization, receipt, and distribution control of these manuals, as well as the responsibility for insuring manual updating throughout the maintenance organization. These responsibilities also apply throughout the entire activity when the Maintenance Department has cognizance of all aeronautical technical manuals for the activity.

Modern technology is constantly changing. Today's best practices may be modified, totally revised, or made obsolete tomorrow. This is not always a planned or intended condition, but it must be accepted and dealt with. Such a condition requires that prompt action be taken to change and revise material related to the technical information and data used by maintenance and operations personnel. The urgency of this action depends upon the type of information involved and the frequency of reference to the affected directives or manuals. However, technical data change and revision material, once it has been screened and routed, should not be allowed to accumulate at any point. Procedures must be established throughout the organization to insure prompt action in revising and updating all technical information and data. It is mandatory that those responsible for the management of the technical library also be responsible for insuring that technical change and revision material reaches all department levels having copies of the affected directives or publications.

TPL (Technical Publication Location Cards) should be maintained in the QA Division to indicate the location of all publications within the department. Proper use of this card will provide effective technical manual management within the central and dispersed libraries. Change Entry Certification form (OpNav Form 5070-12) should be used to insure that all change and revision material is entered in the directives and manuals that are not physically maintained in the technical library.

PROCUREMENT OF DATA

The AO supervisor must continue an effective program of review of the publications and other technical data required by his department, division, branch, or crew. Publications and directives are provided to aid the supervisor and worker in meeting the commands commitments. As new data are published, it must be made available to the worker. This is a responsibility of the supervisor, who must know the procedures for requisitioning and how to be placed on the automatic distribution list.

MAILING LIST REQUEST FOR AERONAUTICAL TECHNICAL PUBLICATIONS (NAVAIR FORM 5605/3)

Future issues of aeronautical publications and technical directives that are needed on a continuing basis can be received automatically by submitting two copies of NavAir Form 5605/3 to Naval Air Technical Services Facility (NATSF) in Philadelphia, Pa. When new publications or directives are published, NATSF automatically makes distribution to activities on the Standard Navy Distribution List. (This list is prepared from the NavAir Forms 5605/3 received). NavAir Form 5605/3 is a four-part form. Each part is used to request addition to the mailing list for the types of publications listed on each part.

Submission of this form is normally accomplished by the Quality Assurance Division (G Division aboard carriers for AO's) for all divisions of a maintenance department in a squadron.

Part 1.—Part 1 of NavAir Form 5605/3 is used when an activity has a continuing requirement for Allowance Lists, Indexes, and General Series Technical Manuals/Directives.

Part 2.—Part 2 of NavAir Form 5605/3 is used when an activity has a continuing requirement for Allowance Lists, Airframe Manuals/ Technical Directives, and Powerplant Manuals/ Technical Directives.

Part 3.—Part 3 of NavAir Form 5605/3 is used when an activity has a continuing requirement for Component Manuals.

Part 4.—Part 4 of NavAir Form 5605/3 is used when an activity has a continuing requirement for Ship Installation Manuals/Technical Directives.

PROCUREMENT OF EXISTING DATA

Manuals that are current cannot be requested on NavAir Form 5605/3. Data that is already distributed is requested in different ways, depending on the type of data and the originator.

NavAirSysCom Manuals

NavAirSysCom manual type publications are ordered by preparing and submitting the Single Line Item Requisitioning System Document (DD Form 1348 or DD Form 1348M) in accordance with the Military Standard Requisitioning and Issue Procedure (MILSTRIP) as outlined in NavSup Pub 437. These manuals can be received by submitting a DD 1348 to the supply point listed on the inside cover of NavSup Manual 2002. NavSup Publication 2002, Section VIII, Part C, contains a listing of all NavAirSysCom Manual publications and their stock numbers.

NavAirSysCom Letter Type Technical Directives

NavAirSysCom letter type technical directives listed in NavSup Pub 2002, Section VIII, Part D, may be requested on DD Form 1149. The request form should be forwarded to Naval

Publications Form Center (NPFC) for all technical directives listed except for those denoted with an asterisk. Those identified by an asterisk may be procured by submitting a letter of justification to Naval Air Technical Service Facility (NATSF) in Philadelphia, Pa.

NavOrdSysCom Publications

Manuals issued by the Naval Ordnance Systems Command are as follows:

Ordnance Pamphlet (OP)
Ordnance Data (OD)

As some OP's are revised they are redesigned as NavAir publications. OP 0 (Index of Ordnance Publications) contains a complete listing of all ordnance publications. OP 0 provides the reader with the information for ordering OP's and OD's. OP's and OD's listed in NavSup Pub 2002, Section VIII, Part C, are requisitioned on form DD 1348.

Armament bulletins and changes are listed in NavSup Pub 2002, Section VIII, Part D. Armament bulletins and changes are requisitioned the same as any other NavAirSysCom technical directive (on DD Form 1149).

Instructions and Notices

Navy directives of the instruction and notice type are requisitioned on NavSup Form 1205. Activities desiring additional copies of an instruction or notice should submit the request to the originator of the directive.

SECURITY

Commanding officers are responsible for establishing security orientation, education, and training programs for all personnel assigned. OpNav Instruction 5510.1 (Series), chapter 3, provides the necessary minimum requirements for implementing these programs.

The central aim of the security education program is to make all personnel "security-minded." To achieve this, a continuing training program must be in use at all levels of the command, with emphasis by the senior petty officers to their subordinates.

Effective security also requires that the handling of classified materials be managed in an efficient manner. Good management practices are important in obtaining effective security control. If security needs are to be met, constant attention must be given to the way in which classified material is handled. The guide for handling and control of classified material is OpNav Instruction 5510.49 (Series).

SECURITY ORIENTATION, EDUCATION, AND TRAINING PROGRAM

The security orientation, education, and training program of each command must include all personnel entrusted with classified information regardless of their position, rank, or grade. The program must be designed to include the following:

1. Familiarize all personnel with the security requirements with which they have to comply for proper performance of their duties and assignments.
2. Remind all echelons of command of their responsibility for assuring that classified defense information is effectively and economically safeguarded.
3. Insure willing, conscientious compliance with security regulations, procedures, and practices.
4. Remind all echelons of command of their responsibilities in the classification management program to include classification, upgrading, downgrading, and declassification processes as set forth in OpNav Instruction 5510.1 (Series).
5. Advise all personnel who have access to classified information of the hazards of its disclosure to any person not authorized to receive it and of their responsibility for exercising personal vigilance for its protection.
6. Inform all personnel of the techniques and devices employed by foreign intelligence activities in attempting to obtain U.S. classified defense information and of their responsibility for reporting such attempts.
7. Advise all personnel of the hazards involved in, and the strict prohibition against, discussing classified information over the telephone.
8. The attention of all personnel must be directed to the disciplinary action (Article 0815 of OpNav Instruction 5510.1 (Series)) that may result from violation of security regulations.

Personnel Indoctrination

Persons being assigned to duties requiring access to classified information, prior to being granted access, must be indoctrinated on the security aspects and responsibilities of their assignment. The indoctrination must include the strict prohibition against discussing classified information over the telephone. This is especially important because of the fact that a high proportion of calls are transmitted through microwave transmitters and can be easily recorded and analyzed. The types of situations to be avoided when talking on the telephone are as follows:

1. Allowing classified information to slip into conversations through carelessness.
2. Disclosure of classified information in order to expedite the completion of a "rush project."
3. Use of codes, "double talk," or attempt to talk around classified information. It should be noted that private codes and "talking around" classified matters presents no real protection against the abilities of a trained analyst.
4. Attempts by Department of the Navy Personnel to provide unauthorized services, information, or documents to anyone believed to be in contact with a foreign intelligence service.
5. Attempts by persons living in communist countries to obtain information of intelligence value from personnel by correspondence (including "Pen Pal" correspondence), questionnaires, "ham radio" activity, naval cachets (request to service postal covers), or other forms of communications.

Senior petty officers to whom information of the above nature becomes known will perform the following:

1. Instruct the reporting individual to take no action to exploit, apprehend, restrict, or stimulate further contact until appropriate guidance or instructions are received.
2. Report full details expeditiously to the commanding officer who will report to the nearest Naval Investigative Service Office.

Briefings and Debriefings

Periodic briefings must be held by all commands for personnel having access to classified information. These briefings must include special emphasis on the subjects discussed in Article 0305 of OpNav Instruction 5510.1 (Series).

In addition to the periodic security briefings the former article also contains information of foreign travel briefings and potential hostage briefings.

Article 0306 of the Security Manual provides the necessary information for debriefing personnel who have had access to classified information and the security access has been terminated for any reason.

As part of the indoctrination program, personnel will be instructed to report promptly any of the following types of information:

1. Attempts by representatives or citizens of communist controlled countries to cultivate friendships or to place personnel under obligation.
2. Attempts by representatives or citizens of foreign governments to:
    a. Cultivate a friendship to the extent of placing them under obligation, which they would not normally be able to reciprocate, or by money payments or bribery to obtain information of intelligence value.
    b. Obtain information of intelligence value through observation, collection of documents, or by personal contact.
    c. Coerce personnel by blackmail; by threats against or promises of assistance to relatives living under their control, especially those in a communist country.
    d. Appeal to personnel on a racial, nationalistic, or ideological basis.
    e. Exploit personnel who may be disaffected or in personal difficulties.
    f. Intimidate, harass, entrap, discredit, search, spy on, or recruit for intelligence purposes personnel traveling in communist countries.
    g. Induce personnel to defect or to induce those who have fled from communist countries to redefect.

CLASSIFICATION

Information that will aid the senior petty officer in safeguarding classified material can be found in Articles 0405, 0406, 0423, 0424, 0426, 0432, and 0443 of the Security Manual. The contents of these articles should be familiar to all senior petty officers.

Regrading and Declassification

Overclassification of information and retention of information in classified status when it no longer requires such protection cause unnecessary delay and expense in handling and transmission, overburden stowage facilities, and depreciate the classification system. Under such circumstances, security control is virtually impossible to enforce and to maintain. Therefore, downgrading and declassification must be accomplished whenever possible.

A mandatory, continuing program based on a time schedule for automatically downgrading, and in most cases automatically declassifying, documents originated within the Department of Defense has been established by the Secretary of Defense. Determination of specific dates or passage of events that will provide early downgrading or declassification should be made as a matter of practice. When this is not possible, classified material must be categorized into one of the four groups described in the following paragraphs for automatic downgrading and declassification of classified information.

Downgrading and Declassification Groups:

Group 1 Material

Material in this group is completely excluded from the automatic downgrading and declassification provisions either because it has been removed from such provision or because it contains information not subject to the classification jurisdiction of the Executive Branch of the U.S. Government.

Group 1 material may be downgraded or declassified only by the originating authority, or by an official higher in the same chain of command.

Group 2 Material

Material in this group is exempt from automatic downgrading and automatic declassification because it contains extremely sensitive information originally classified TOP SECRET or SECRET.

The authority for designating material as Group 2 is granted only to those officials empowered to exercise original TOP SECRET classification authority. This authority may not be delegated and must be exercised only when required in the interest of national security. It is intended that the number of Group 2 documents be kept to an absolute minimum.

Group 2 material may be downgraded or declassified only by the originating authority or by an official higher in the same chain of command.

Group 3 Material

Material in this group warrants some degree of classification for an indefinite period. Group 3 material is exempt from automatic declassification. Unless the originator specifies a shorter interval, they shall be downgraded automatically as follows:

a. TOP SECRET material will be downgraded to SECRET 12 years from date it was created and to CONFIDENTIAL 24 years from date it was created, and will remain CONFIDENTIAL.

b. SECRET material will be downgraded to CONFIDENTIAL in 12 years, and will remain CONFIDENTIAL.

c. CONFIDENTIAL material will remain classified.

Group 3 material may be declassified only by the originating authority or by an official higher in the same chain of command.

Group 4 Material

Group 4 material includes all classified material which does not qualify, or is not assigned to, one of the first three groups.

Group 4 material is automatically downgraded and declassified as follows:

a. TOP SECRET material will be downgraded to:

(1) SECRET 3 years from date it was created.

(2) CONFIDENTIAL 6 years from date it was created; and

(3) Declassified 12 years from the date it was created.

b. SECRET material will be downgraded to:

(1) CONFIDENTIAL 3 years from the date it was created; and

(2) Declassified 12 years from the date it was created.

c. CONFIDENTIAL material will be automatically declassified 12 years from the date it was created.

Each original and derivative classifying authority is similarly authorized to reclassify and declassify official information previously classified by virtue of his position. Such authority includes changing the downgrading and declassification group to which information may be initially assigned.

Custodians are authorized to reclassify and declassify classified information in accordance with the downgrading and declassification markings affixed to classified information. In the case of classified information received via a receipt or logbook signature system, the Classified Material Control Officer will be notified whenever a document has been remarked in accordance with this paragraph.

Higher authority in the chain of command or higher authority primary cognizance over the subject matter involved must correct an erroneous classification which has been assigned by a subordinate, or downgrade or declassify information when such action is deemed appropriate.

When the interests of two or more commands are involved in the reclassification of information, coordination between such commands is required.

ROUTING AND HANDLING OFFICIAL CORRESPONDENCE

The fact that official correspondence is originated implies that information is being requested or furnished. It follows that unless this information is properly disseminated, the mere originating has accomplished very little. Correspondence requesting a report does not produce the report unless the person responsible for its preparation receives the request.

The responsibility for the dissemination and proper handling of official correspondence is assigned to a specific organizational component of the Weapons Department.

INCOMING CORRESPONDENCE

Official correspondence received by the Weapons Department should ultimately become a part of the permanent records of the department. The routing required between the receipt of and the filing of the correspondence depends upon the type of information furnished and/or the action required. Local procedures usually prescribe a standard routing for all incoming correspondence in addition to the routing to those individuals or organizational components primarily concerned with the individual communication.

A route sheet similar to figure 2-3 is usually employed to insure the proper routing of correspondence requiring action. This should be prepared in duplicate with the original attached to the correspondence being routed and the copy being retained. As the correspondence progresses through the routing indicated, appropriate action is taken and the routing sheet is initialed by the responsible individuals. When the routing is complete, the correspondence with the original route sheet is returned for filing.

The routing may be placed on the correspondence itself if the correspondence is in the nature of information. This may be accomplished by the use of a rubber stamp. (See fig. 2-4.)

OUTGOING CORRESPONDENCE

Outgoing correspondence is prepared by the correspondence organizational component, utilizing a rough draft prepared by the originator. The letter is then presented to the appropriate official for signature.

The correspondence file which accompanies the letter to be signed is arranged according to the instructions of the signing official.

After the signature is obtained, the correspondence is dated with the date on which it is signed, the file copies removed for filing, and the correspondence forwarded to the appropriate addressees.

The preparation of letters for window type envelopes is recommended for the transmittal of all unclassified letters of a routine nature which cannot be mailed in bulk. The chief advantages in using window envelopes are as follows:

1. Time is saved in that the name and address of the recipient are typed only once.
2. Errors in mailing are reduced in that a letter cannot be sent out in the wrong envelope.

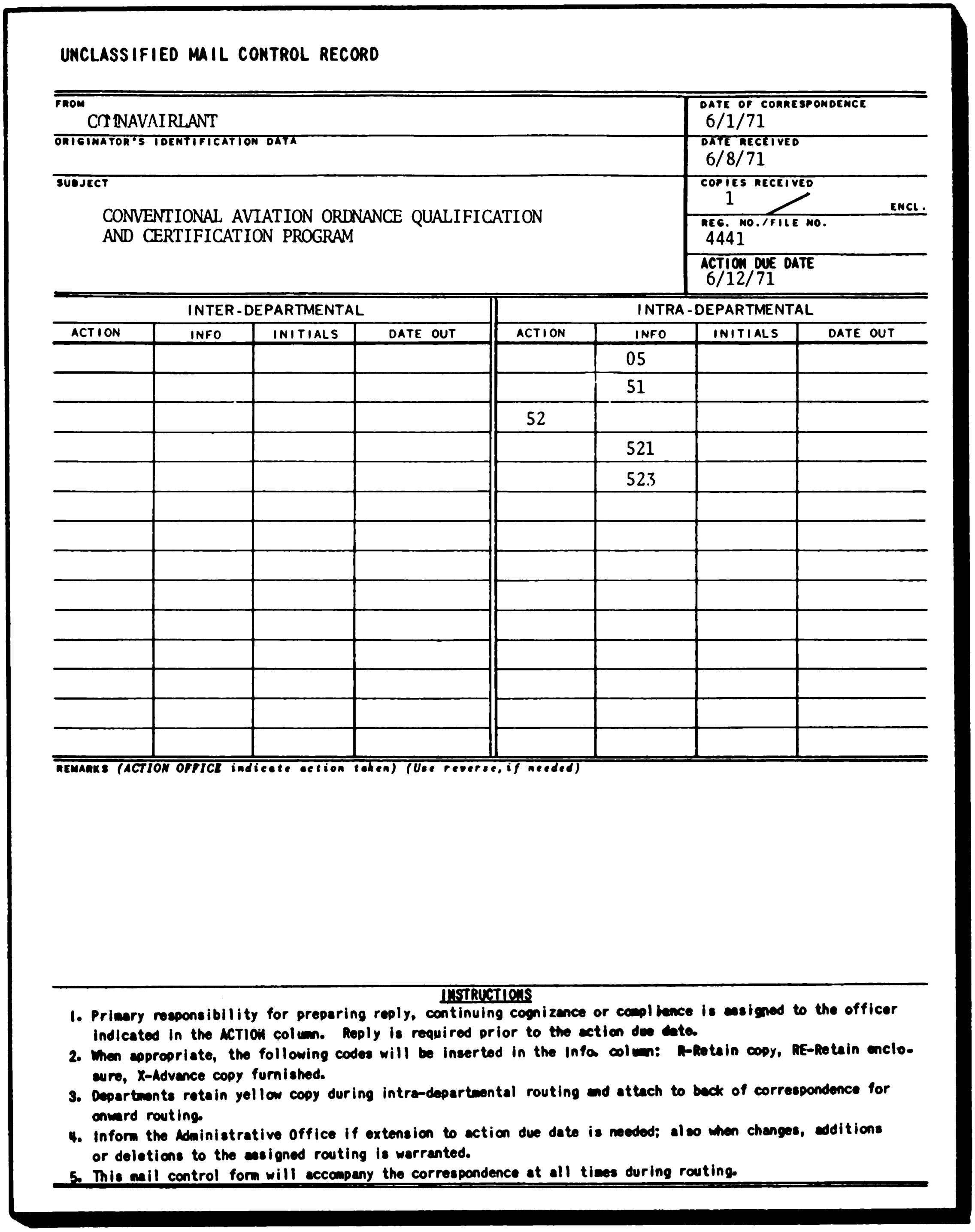
Since much of the material and correspondence handled by an AO is classified, he should know how to handle classified material and he should be familiar with the classification and special markings required on classified correspondence as set forth in the Navy Security Manual for Classified Information, OpNavInst 5510.1 (Series) and the Department of the Navy Correspondence Manual, SecNavInst 5216.5 (Series). Certain classification and special markings must appear on classified letters as described in the following paragraphs.

Security Classification

The appropriate designation—TOP SECRET, SECRET, or CONFIDENTIAL—is typed in capital letters at the left margin one line below the special postal service, if any, or five lines below the last line of the address in the letterhead. The classification is also typed in capital letters one-half inch from the bottom of the page, ending flush with the right margin.

When a letter is classified solely because it forwards classified material and can be downgraded or unclassified upon the removal of this material, a statement to this effect is typed or stamped after the security classification which appears at the left margin at the top of the page.

In addition to the typed classification, the classification should be immediately stamped or marked at the upper right corner and the lower right corner in capital letters that are larger than the type used in the text of the letter, and when practicable, should be in red.



UNCLASSIFIED MAIL CONTROL RECORD

FROM
COMNAVAIRLANT

DATE OF CORRESPONDENCE
6/1/71

ORIGINATOR'S IDENTIFICATION DATA

DATE RECEIVED
6/8/71

SUBJECT
CONVENTIONAL AVIATION ORDNANCE QUALIFICATION AND CERTIFICATION PROGRAM

COPIES RECEIVED
1 / ENCL.

REG. NO./FILE NO.
4441

ACTION DUE DATE
6/12/71

INTER-DEPARTMENTAL				INTRA-DEPARTMENTAL			
ACTION	INFO	INITIALS	DATE OUT	ACTION	INFO	INITIALS	DATE OUT
					05		
					51		
				52			
					521		
					523		

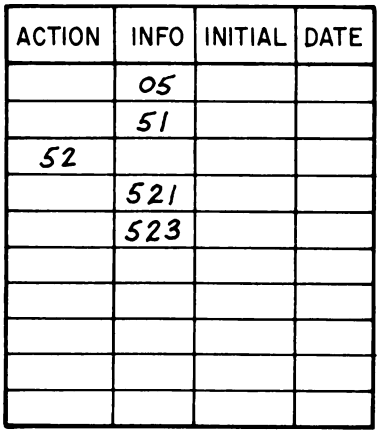
REMARKS *(ACTION OFFICE indicate action taken) (Use reverse, if needed)*

INSTRUCTIONS

1. Primary responsibility for preparing reply, continuing cognizance or compliance is assigned to the officer indicated in the ACTION column. Reply is required prior to the action due date.
2. When appropriate, the following codes will be inserted in the Info. column: R-Retain copy, RE-Retain enclosure, X-Advance copy furnished.
3. Departments retain yellow copy during intra-departmental routing and attach to back of correspondence for onward routing.
4. Inform the Administrative Office if extension to action due date is needed; also when changes, additions or deletions to the assigned routing is warranted.
5. This mail control form will accompany the correspondence at all times during routing.

AO.495

Figure 2-3.–Route sheet.



ACTION	INFO	INITIAL	DATE
	05		
	51		
52			
	521		
	523		

AO.496

Figure 2-4.—Routing stamp.

On succeeding pages, the classification is typed in capital letters at the left margin, 1 inch, or 6 lines, from the top of the page. The classification is repeated at the bottom of all pages, one-half inch from the lower edge and ending flush with the right margin. In addition, the serial number on a classified letter is preceded by one or more 0's to indicate the degree of classification. One 0 indicates Confidential, two 0's Secret, and three 0's Top Secret.

Subject Markings

The originator should assign an unclassified subject to the letter whenever consistent with security and clarity. In all cases, however, the initials of the classification assigned to the subject, standing alone, are indicated in parentheses immediately following the subject, using one of the following notations: (U), (C), (S), or (TS). It is not necessary to assign one of the above notations to the subject if it has been indicated that the letter is unclassified upon removal of enclosures or basic material.

Classified References

Referencing a classified letter is accomplished in the same manner as an unclassified letter, except that the classification assigned to the basic letter is shown after the abbreviated short title of the activity originating the reference or the location of the activity if included.

1 Paragraph Markings

Paragraphs of classified letters when not of the same classification as the overall classification of the letter are marked to show the degree of classification by placing the appropriate markings immediately preceding and to the left of the paragraphs involved, following the paragraph number. The symbols (TS) for Top Secret, (S) for Secret, (C) for Confidential, (FOUO) for For Official Use Only, and (U) for Unclassified are used as appropriate.

When information contained in all of the paragraphs of the document is of the same classification as the overall classification of the document itself, there is no need to mark the paragraphs individually. If paragraph markings are impracticable or different items of information in one paragraph require different classifications, provisions in the current edition of OpNavInst 5510.1, Department of the Navy Security Manual for Classified Information, are governing.

Automatic Time-Phased Downgrading and Declassification Marking

Each classified document originated by the Naval Establishment must bear a special notation which identifies its status in the automatic time-phased downgrading and declassification system in accordance with the provisions of the current edition of OpNavInst 5500.40, Automatic Time Phased Downgrading and Declassification System. The assignment of the appropriate downgrading and declassification information to the document is the responsibility of the writer. Normally, the letter bears the date or event subsequent to which the document will be downgraded or declassified in accordance with the provisions of the above instruction and the current edition of OpNavInst 5510.1. One of the following notations, as appropriate, will be indicated on the letter:

1. Downgraded to Secret on (date, or after specific event).
2. Downgraded to Confidential (or when appropriate. Confidential-Modified Handling Authorized) on (date, or after specific event).
3. Unclassified on (date, or after specific event).

When it is not possible to assign a specific date or event subsequent to which the document may be downgraded or declassified, the document must be assigned by the writer to one of the four automatic time-phased downgrading and declassification groups established for this purpose. One of the following notations, as appropriate, should be stamped or marked on each document:

1. GROUP-1. Excluded from automatic downgrading and declassification.
2. GROUP-2. Exempted from automatic downgrading.
3. GROUP-3. Downgraded at 12-year intervals: not automatically declassified.
4. GROUP-4. Downgraded at 3-year intervals; declassified after 12 years.

The appropriate downgrading and declassification notation appears on the first page of each separate part of the document approximately 1 inch from the bottom of the page.

For Official Use Only

The term "For Official Use Only" (FOUO) is assigned to official unclassified information which requires protection in accordance with statutory requirements or in the public interest, but which is not in the purview of the rules for safeguarding information in the interest of national defense. Its description, use, and limitations are set forth in the current issue of SecNavInst 5570.2, Policy Governing the Custody, Use, and Preservation of DOD Official Information Which Requires Protection in the Public Interest. When a letter is so designated, this notation is typed, in capitals, at the left margin on the line below the special postal service, if any, or five lines below the last line of the address in the letterhead on the first page. On second and succeeding pages the designation is typed 1 inch from the top of the page at the left margin and at the bottom of all pages one-half inch from the lower edge ending flush with the right margin.

Other Markings

Correspondence which contains Restricted Data, Formerly Restricted Data, and other categories of information which require special markings, in addition to those prescribed for classified correspondence, will be marked in accordance with the provisions of the current edition of OpNavInst 5510.1, Department of the Navy Security Manual for Classified Information.

Prior to preparing classified matter for mailing, the provisions of the Department of the Navy Security Manual for Classified Information should be clearly understood and followed. Top Secret may not be sent through any postal system, United States or foreign. Secret may be sent by United States registered mail. Confidential may be sent by United States registered or certified mail. Classified matter may not be sent through foreign mails. When classified material is transmitted through the U.S. mails, it must be enclosed in two sealed envelopes. The inner envelope shows the address, classification, and any other special instructions. The outer envelope is fully addressed but is not marked with the security classification or any other unusual data or marks which might invite special attention.

Outgoing messages are normally hand carried to the communications center for transmitting. A copy of each outgoing message should be extracted and held in a suspense file, pending receipt of the return copy from the communications center containing the date time group number.

TICKLER FILE

Another responsibility which normally is assigned to the correspondence AO is the maintenance of a system to insure the timely submission of replies to incoming correspondence or to insure the preparation of required reports. A tickler file is commonly established for this purpose. A tickler file is established simply as a reminder that some action is required prior to a certain date. The method most suitable for local conditions, considering size of operations and the amount of correspondence handled, should be employed. The methods described in the following pargaraphs are frequently used.

The retained copies of the route sheet may be utilized as a reminder for replies or reports of a one-time nature. They should be maintained by the date that the reply or report is due and retained until the required action is completed. If transmission of correspondence is required, sufficient time should be allowed to insure its transmission to the recipient by the due date.

For reports or other action of a more permanent or continuing nature, file folders may be used. These may be numbered from 1 to 31, corresponding to the days of the month. Notes listing action required, date required, background information, and reference data are filed in the folders according to due date. The folder for the current day is pulled each morning and refiled in the back of the file after contents are noted and after it is ascertained that the required action has been taken. When it is found that the required action has not been taken, the correspondence AO should follow up with the responsible personnel.

FILING CORRESPONDENCE

The Department of the Navy Standard Subject Identification Code, SecNav Instruction 5210.11 (Series) provides a single, standard subject scheme. This classification system is used for classifying Navy and Marine Corps documents by subject throughout the Department of the Navy. SecNav Instruction 5210.11 contains a list of standard subject classification numbers and a list of name-title subject classification codes. Except at activities with an exceptionally large volume of correspondence, files normally are established by subject classification numbers. However, files may be established by name-title codes or a combination of both. These classification numbers/codes and their use are discussed in the following paragraphs.

Directives Issuance System

The directives issuance system provides a uniform plan for issuing and maintaining directives. Directives consist of written matter which prescribes or establishes policy, organization methods, or procedure; require action; or contain information essential to the effective administration or operation of activities concerned.

Instructions are directives of a continuing nature and remain in effect until subsequently canceled. Notices are directives of a one-time nature or directives which are applicable for a brief period of time (usually 6 months or less). Each notice contains a provision for cancellation, on which a specific date is stated for record purposes.

For the purpose of identification and filing, standard subject classification numbers classify Navy correspondence and directives under 13 major series groups. These major series groups are further subdivided by use of the last 3 digits in the major series. The 13 major series groups consist of the following:

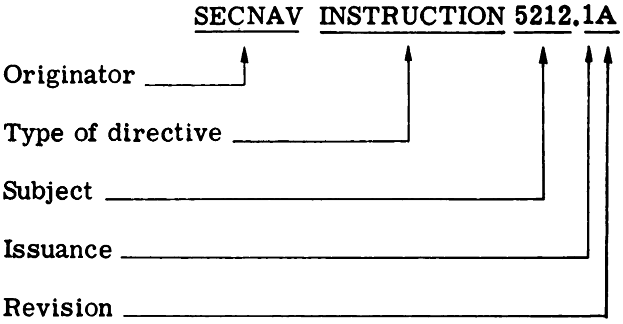
1000 Series—Military Personnel.
2000 Series—Communications.
3000 Series—Operations and Readiness.
4000 Series—Logistics.
5000 Series—General Administration and Management.
6000 Series—Medicine and Dentistry.
7000 Series—Financial Management.
8000 Series—Ordnance Material.
9000 Series—Ships Design and Ships Material.
10000 Series—General Material.
11000 Series—Facilities and Activities Ashore.
12000 Series—Civilian Personnel.
13000 Series—Aeronautical Material.

Table 2-1 lists the 8000-8999 primary and secondary subjects.

Each office identifies the directives which it originates by the following:

1. The originator's abbreviation.
2. The type of directive.
3. The subject classification number.
4. A consecutive number, preceded by a decimal point (applies to instructions only).
5. A consecutive letter, indicating the revision.

The following example is an identifying symbol assigned to an instruction issued by the Office of the Secretary of the Navy:



Consecutive numbers are assigned to instructions having the same subject classification number to show the order of issuance. For example, the subject number of General Ammunition and Explosives is 8010. An originating office would assign numbers to the first, second, and third instructions which it issues on the same subject as follows: 8010.1, 8010.2, and 8010.3 respectively. The number 8010.1A indicates the first revision of the instruction 8010.1.

Table 2-1.—Ordnance material 8000-8999.

8000-8199	GENERAL ORDNANCE MATERIAL, AMMUNITION AND EXPLOSIVES
8000	Ordnance Material, General
8005	Technical Information and Modifications (MarCorps only)
8010	Ammunition and Explosives, General
8011	Allowances
8012	Distribution and Issue
8013	Fleet Return Ammunition
8014	Maintenance and Rework/Renovation
8015	Ammunition Stock Recording Systems
8020	Ammunition and Explosives Safety
8021	Packaging and Carloading
8022	Cargo Ship Loading
8023	Handling, Stowage, and Transportation
8024	Restrictions and Suspensions
8025	Casualties and Malfunctions
8026	Disposition of Ammunition
8027	Explosive Ordnance Disposal (See also 3571)
8030	Gun Ammunition
8031	20-mm and 40-mm
8032	3 Inch
8033	5 Inch
8034	6 Inch and larger
8035	Saluting Gun Ammunition
8036	Line-Throwing Gun Ammunition
8037	Aircraft Gun Ammunition
8040	Rockets
8041	Surface
8042	Aircraft
8043	Ground
8050	Pyrotechnics
8051	Surface
8052	Air
8053	Subsurface
8054	Ground
8060	Demolition Material
8061	Amphibious and Underwater
8070	Atomic, Biological, and Chemical Warfare Material
8071	Atomic Warfare Material
8072	Biological Warfare Material
8073	Chemical Warfare Material
8090	Land Type and Marine Corps Ammunition
8091	Small Arms Ammunition
8092	Land Mines
8093	Grenades
8094	Artillery
8095	Mortar
8110	Special Weapons
8130	Drill and Training Ammunition (All types)
8150	Bombs
8190	Miscellaneous Ammunition and Explosives Material
8191	JATOS
8200-8299	FIRE CONTROL AND OPTICS
8200	General
8210	Optics
8220	Gun Fire Control
8221	Systems
8222	Radar
8223	Directors
8224	Computers and Rangekeepers
8225	Battery Alignment
8226	Ballistics
8227	Gun Sights
8230	Target Designation Systems
8240	Airborne Fire Control
8241	Systems
8242	Radar
8243	Gun Sights
8244	Computers
8245	Bombsights and Bomb Directors
8250	Rocket Fire Control
8260	Guided Missile Fire Control
8261	Systems
8262	Radar
8263	Directors
8264	Computers
8270	Stable Elements
8280	Underwater Fire Control
8281	Surface Ship
8282	Submarine
8300-8399	GUNS AND MOUNTS
8300	General
8310	3 Inch
8311	3"/50 Caliber
8312	3"/70 Caliber
8320	5 Inch
8321	5 "/25 Caliber
8322	5"/38 Caliber
8323	5 "/54 Caliber
8330	6 Inch and Larger
8331	6 "/47 Caliber
8332	8 "/55 Caliber
8333	12 "/50 Caliber
8334	14 "/50 Caliber
8335	16 "/45 and 16 "/50 Caliber
8350	Line-Throwing Guns
8360	Machine Guns (Surface)
8361	30 Caliber and 50 Caliber
8362	20-mm
8363	40-mm
8370	Small Arms and Landing Force Equipment
8373	Special Rifle Team Equipment
8380	Airborne Guns, Launchers, and Racks
8381	Guns
8382	Bomb Racks
8383	Rocket Racks and Launchers
8390	Missile Launchers and Projectors
8391	Projectors and Launchers (A/S)
8392	Depth Charge Release Tracks
8393	Rocket Launchers
8394	Guided Missile Launchers
8395	Torpedo Tubes
8396	Torpedo Launching Racks
8400-8499	COMBAT VEHICLES
8400	General
8410	Landing Vehicles, Tracked (LVT)
8411	Personnel and Cargo Carriers

Table 2-1.—Ordnance material 8000-8999—Continued.

8412	AAA Weapons and Cargo Carriers
8413	Engineer Vehicles
8414	Howitzer Carriages
8415	Recovery Vehicles
8416	Utility Vehicles
8420	Tanks and Self-Propelled Artillery
8421	Gun Tank (90mm and smaller)
8422	Gun Tank (Larger than 90mm)
8423	Flamethrower Tanks
8424	Recovery Vehicle
8425	Self-Propelled Artillery (155 mm gun and larger)
8426	Self-Propelled Artillery (Smaller than 155mm gun) and Tractor
8430	Wheeled and Half-Tracked Vehicles
8440	Amphibious Vehicles
8500-8599	UNDERWATER ORDNANCE
8500	General
8510	Torpedoes
8512	Aircraft Launched
8513	Submarine Launched
8514	Surface Launched
8530	Depth Charges
8535	Depth Bombs
8540	Projector Charges and Rockets
8550	Mines
8551	Aircraft Laid
8553	Submarine Laid
8554	Surface Laid
8560	Harbor Defense Equipment (include nets, booms, controlled mines, and associated acoustic systems)
8570	Underwater Countermeasures and Evasion Devices
8571	Ordnance Locators
8600-8799	AVIATION ORDNANCE
8600	General
8800-8899	GUIDED MISSILE WEAPONS
8800	General
8805	Technical Information and Modifications (MarCorps only)
8810	Intercept-Aerial (AIM, CIM, LIM, MIM, RIM)
8820	Surface Attack (AGM, CGM, HGM, LGM, MGM, PGM, RGM, UGM)
8830	Underwater Attack (UUM)
8840	Drones (AQM, MQM, BQM)
8850	Training (ATM, MTM)
8900-8999	MISCELLANEOUS ORDNANCE MATERIAL
8900	General
8950	Deperming and Degaussing
8960	Armor

Notices are not assigned consecutive numbers because of their onetime nature or brief duration. The subject classification number assigned as the file number of a letter is not assigned a consecutive number.

The security classification of Confidential or Secret instructions and notices is indicated by prefixing the subject number by 0 for Confidential and by 00 for Secret.

Name-Title Subject Classification Codes

Name-title codes (alphabetic or alphabetic-numeric codes) are provided for names and titles frequently used by the Department of the Navy. These codes may be used for classifying and filing documents by name or organizational designation except that they are not to be used in assigning subject numbers to directives. Included are symbols for fleet organizations, the United States Government, foreign governments, commercial enterprises and firms; classes of personnel; types of naval activities; and official symbols for classes and types of aircraft, vessels, and guided missiles.

The first letter of the name or title code designates the larger organizational group, and the second or third letters designates a further breakdown of the larger group. For example, "NA" designates naval air stations. The "N" is for the Naval Shore Establishment and the "A" for air stations.

An Arabic numeral added to the letter symbol further subdivides the code. For example:

FF Fleets, Forces, Types, Areas and Sea Frontiers
FF1 U. S. Fleet
FF2 U. S. Task Fleets

Files

File arrangement within any office depends upon the mission of the office and on the volume of its official correspondence. Normally, general correspondence is stored in metal file cabinets. This includes letters, speedletters, and memorandums received or originated by the office.

Folders are used to keep correspondence orderly in the files. Standard file folders are available in two sizes—letter size (9 x 11 3/4 inches) and legal size (9 x 14 3/4 inches). The total number of folders and the appropriate primary, secondary, or tertiary subject classification numbers, or the name-title symbols, to be used are determined by the volume of written matter in each category to be filed. There may be no need to establish any folders on some major series groups, while others may require several folders broken down to primary, secondary or tertiary numbers. The subject classification numbers or name-title symbols should be printed on each folder.

The subject classification number placed on the correspondence by the originator assists in determining the correct folder in which to file the correspondence. This number, however, may not be appropriate for the particular office concerned, thereby requiring reclassifying. The proper method of classifying a document for the purpose of selecting the appropriate file is to read it carefully and analyze it, considering the following factors:

1. The most important, definite, or concrete subject mentioned.
2. The purpose or general significance of the document.
3. The manner in which similar documents are requested by users of the files.
4. The subject classification code under which previous documents of a similar nature are filed.

Directives are not placed in the general correspondence files except when copies of instructions and notices are attached to or interfiled in such files when needed to complete a record or document. Instructions are filed in standard three-ring binders and are arranged as follows:

1. In numerical order of subject classification number.
2. By the originating office within each subject classification number.
3. By consecutive number (suffix number) for each originating office.

Notices ordinarily need not be filed because of their brief duration. In cases in which the recipient believes it necessary to file some notices temporarily, they may be interfiled with instructions.

Messages are filed by the date time group number. Normally, two files are maintained—one containing incoming messages and the other containing outgoing messages.

DISPOSITION OF CORRESPONDENCE AND RECORDS

Retention of obsolete and inactive correspondence and records is costly. Such correspondence and records should be destroyed or transferred in accordance with approved records disposal instructions. If this is not performed periodically, the volume of file space required becomes excessive and the files become unwieldy, thus inefficient. The destruction of records is governed by law which requires authorization by proper authority. The authority for destruction of Navy records is contained in SecNav Instruction 5212.5 (Series), Disposal of Navy and Marine Corps Records.

The provisions of SecNav Instruction 5212.5 (Series) are normally amplified by the issuance of local instructions outlining the procedures as they apply locally.

Local Disposition

Not all materials in the files have a record characteristic. In fact, most printed matter found in the weapons department general files fall in the category of nonrecord material. This includes documents that are copies of those filed in the ship's office or station administrative department, or material accumulated in the process of producing records, but which never acquire a record characteristic themselves.

SecNav Instruction 5212.5 (Series), (part II for shore stations and part III for ships) contains the retention standard for naval records. Record materials are listed by broad subject and the retention period is furnished. Nonrecord material may be destroyed locally as soon as it has served its purpose. Records material may be destroyed upon completion of the retention period.

Unclassified records or nonrecords materials authorized for destruction may be placed in wastebaskets and disposed of in the normal manner for trash. Classified matter authorized for destruction should be destroyed by burning in the presence of two designated witnesses. All persons witnessing the destruction of classified material must have security clearances at least as high as the category of material being destroyed. Classified matter may also be destroyed by pulping, provided destruction of the classified material is complete and reconstruction impossible.

CHAPTER 3

MATERIAL CONTROL

An AOC or AO1, especially if in a supervisory billet, will find himself increasingly involved in the details of supporting the man actually doing the work.

Aviation supply personnel are vital members of the aircraft maintenance team; and the AO, as well as other aviation maintenance ratings, must work in close harmony with them if successful teamwork is to be achieved. The team must work so that a flow of materials is maintained from the manufacturer to the man on the job—quite possibly an AO loading out a strike or doing repair work on the other side of the world. A correct concept of supply's relationship to the entire organization is essential in the supervision of aviation armament functions.

ORGANIZATION

The command exercising management control over the policies and procedures of the aviation supply organization is the Naval Material Command. The Chief of the Naval Material Command is usually a rear admiral who is appointed by the President for a term of 4 years with the advice and consent of the Senate. He works with the delegated authority of the Secretary of the Navy, and all orders emanating from him have the full force and effect of SecNav orders.

To better understand the relationship of the Naval Material Command to the Aviation Supply System, it might be well to quickly review the development of the Navy Supply System. Prior to 1842, the commanding officers of ships and stations were responsible for the procurement of their own supplies. They were furnished funds for this purpose by the Navy Department and were required to account for all expenditures. In addition to creating an intolerable burden of paper work on the Navy Department, this procedure had the effect of forcing prices upward, especially when two commanding officers were bidding for some scarce commodity.

In 1842, Congress approved the establishment of a Bureau of the Navy to take cognizance over all matters of naval supply. The primary responsibilities of this infant supply bureau were the procurement, maintenance of custody, and issuance of naval material. They are the primary responsibilities of the Naval Material Command today. Every function of the Naval Material Command is directly related to one or more of these responsibility areas.

In the early years of naval aviation when the Navy had few aircraft, the procurement of spare parts was much like the old system whereby commanding officers dealt directly with the sellers to fill the needs of their command. The pioneer naval aviation project directors had to deal directly with the manufacturers as parts were required.

By 1917, the Naval Aircraft Factory (NAF) in Philadelphia had come into existence and was assigned responsibility for the procuring of aircraft and spare parts. Other responsibilities assumed by NAF include the repair of aircraft, the manufacture of some spare parts, and eventually the manufacture of complete aircraft. There are still many aviators around today who earned their Navy wings in the old N3N, built by NAF.

In 1921, the Bureau of Aeronautics (BuAer) came into being and assumed the responsibility of procuring aircraft and aircraft engines. The responsibility for procuring spare parts and other aeronautical material remained with NAF, which until 1941 was the aviation supply center of the Navy.

The Aviation Supply Office (ASO) was established in 1941 under the technical control of BuAer and the management control of BuSandA. The function of ASO was the procurement, custody, and issuance of aeronautical spare parts and technical material. This is essentially the function of ASO today under the technical comtrol of the Naval Air Systems Command. Management Control is vested in the Naval Material Command.

RESPONSIBILITIES OF THE NAVAL MATERIAL COMMAND

The general functions of the Naval Material Command within its areas of responsibility include many that are not of primary interest to aviation ordnance personnel in that they are not related to aircraft maintenance. Some of the more important general functions of the Naval Material Command are as follows:

1. Supervises the procurement, receipt, custody, warehousing, and issuance of Navy supplies and materials, exclusive of ammunition, projectiles, mines, explosives, and medical supplies.
2. Supervises and directs the operation of the supply phases of Navy Material and administers the redistribution program of excess personal property within the Department of Defense and the sale of Navy surplus property.
3. Authorizes and supervises the transportation of Navy property.
4. Prepares budget estimates and administers funds for the supply distribution system.
5. Renders an annual report to the Congress of the money value of supplies on hand at the various stations at the beginning of each fiscal year and the disposition thereof, of the purchase and expenditure of supplies for the year, and of the balance on hand.
6. Coordinates the compilation of and arranges for the printing of the Catalog of Navy Material.

Some additional functions of the Naval Material Command that are of interest to naval aviation maintenance personnel are the general functions of ASO.

Aviation Supply Office (ASO)

The primary Navy inventory control point (ICP) responsible for material support of the Naval Aviation Maintenance Program (NAMP) with respect to technical aviation material is ASO. Technical aviation material consists of spares and spare parts for aircraft, engines, avionic, electrical, accessory, and safety equipments; GSE (common and peculiar); and aeronautical photographic and meteorological equipment. The responsibilities of ASO include, but are not limited to, the following:

1. The determination of aviation requirements in both range and depth. This responsibility includes the conducting and coordinating of provisioning conferences and the identification and transfer of items to be managed by the (Defense Supply Agency (DSA), and other cognizant ICP's.
2. The budgeting and funding of all assigned aviation material requirements.
3. The procurement of material directly from industry or via other government agencies.
4. The allocation of NavAirSysCom procured materials to stock points; the distribution of material to fill replenishment stock requirements; and the referral of requisitions to stock points to meet end use requirements.
5. The disposal of materials that are in excess to system requirements.
6. The maintenance of aeronautical spares and spare parts catalog. The function includes the obtaining of FSN (Federal Stock Numbers) from the Defense Logistics Systems Center (DLSC).
7. The determination of system asset rework requirements of repairable components to be processed by Navy or commercial rework facilities.
8. The development, issuance, and updating of initial outfitting, allowance, and load lists applicable to the NAMP.

APPROPRIATIONS

At one time or another, almost everyone has had the frustrating experience of not being able to draw from supply some item that he thought necessary to have immediately; the usual reason given being, "We don't have any money left." It takes only a short time to realize that the Navy does not operate with unlimited funds. This section and the following section, titled "Funding," are presented to further an understanding of the system whereby funds are made available at the user activity level for operating expenses.

The main money pool of the government is the General Fund of the Treasury. Funds come into the General Fund from such sources as income taxes, excise taxes, import-export taxes, etc. The only way for money to be expended from the General Fund is by congressional action, which has to be approved by the President. A bill passed by Congress which authorizes the expenditure of funds from the General Fund is called an appropriation.

An estimate of the amount of money required for the operation of the Defense Department during a given fiscal year is prepared by Department of Defense fiscal experts well in advance of the beginning of the fiscal year. The Congress studies the proposed budget in the light of world affairs, the current domestic economy, and such other considerations as they see fit, then acts upon it. They may increase the amount requested, decrease it, or pass it as submitted. After presidential action is completed, the money is made available to the Department of Defense to be spent during a specified year. This is known as an "annual" or "1 year" appropriation.

Congress and the President may also approve "no-year" appropriations for special projects such as large construction over an unspecified length of time. Another form of appropriation is the "multiple-year" appropriation for projects which will be completed in a predictable length of time. An example of this type of appropriation might be the money appropriated to cover the expenses of the NROTC college programs for the next 4 years.

The appropriation by which the AO is most affected is the current year appropriation. After the appropriation or expenditure authorization is received in the Department of Defense, it is prorated among the services as a percentage of their previously submitted budget estimates. The Navy's share is prorated among the various bureaus and commands in essentially the same manner; that is, as a percentage of their estimated requirements for the coming fiscal year. The money to be spent for naval aviation is made available to CNO. Here, part of the money is allocated to ASO for the purchase of aircraft spare parts in quantities which past usage data has indicated will probably be sufficient for the coming year. These spare parts are furnished to the operating activities at no cost, since their usage has been anticipated and the items paid for in advance. The account from which money was spent to buy these items is known as the Appropriation Purchase Account (APA). Material received in the user activities from this account is known as APA material.

Another part of the CNO funds is made available to the operating activities in the form of operating funds.

FUNDING

All aviation activities responsible for operating aircraft are provided funds for certain operational and organizational maintenance expenses under the O&MN (Operations and Maintenance, Navy) appropriation subhead 1911 or in the case of the Naval Air Reserve, O&MN appropriation subhead 1912. These funds are intended to provide for all fundable supplies in the operation of aircraft and for fundable materials used in the organizational maintenance of assigned aircraft. It is intended that funds provided to intermediate maintenance levels will perform the assigned maintenance within their scope, and such funds are not to be used to procure this service from other naval activities. The funds are for fundable supplies only (labor is performed by military personnel and not a fundable charge). Housekeeping, administrative, and other similar expenses are to be provided by the supporting ship or station and are not chargeable to these funds.

Maintenance Funds

Funds used for the operation and maintenance of naval aircraft and related equipment are defined as maintenance funds. Maintenance managers must familiarize themselves with these funds and their respective purposes, since responsibility must be commensurate with funding.

Aircraft Operating Funds

Aircraft operating funds finance the following:

1. Aviation fuels and lubricants (POL) consumed in aircraft.
2. Flight clothing and operational equipment authorized in the NavAir 0035QH-2 allowance list, with the exception of exchangeable aeronautical equipment, such as life vests, rafts, parachutes, etc. (These exceptions are financed by Aviation Maintenance funds.)
3. Squadron administrative (office) consumable supplies.
4. Aerial film used in aircraft.
5. Flight deck/safety shoes used by squadron personnel in the readiness, launch, and recovery of aircraft.

6. Initial issue of unit identification marks or newly reporting personnel.

7. Liquid and breathing oxygen used during light operations by both the aircraft system and pilot.

8. Forms and publications (Cog symbol II) and the printing and reproduction thereof.

9. All reimbursable maintenance material procured when located at other than the parent supporting ship and/or station, including APA material procured from other Government agencies or commercial concerns, by aircraft on exended flights. (This does not include aircraft maintenance funds, which are furnished by the Operations Maintenance Division of the station at which the aircraft has landed.)

10. Liquid oxygen.

Air Staff Administration and Operations Funds

Air Staff Administration and Operations funds finance the following:

1. Administrative office supplies for daily operations.
2. Office equipment and accessories not classified as investment items.
3. Rental of office machines on a contract basis.
4. Special incentive awards for staff or aviation units. These awards should contribute towards motivation and a high degree of morale and be purchased on a minimum basis.
5. Special flag office accessory items.

Aviation Outfitting Funds

Aviation outfitting funds are made available to finance the initial outfitting of all allowance list and Table of Basic Allowances (TBA) equipment issued to Navy squadrons and deployable aircraft, as organizational property and the replacement of authorized organizational property with nonconsumable material accountability and recoverability codes.

1. Initial outfitting is defined as:
   a. Initial issue of any item or organizational property to a squadron or unit during an interval from the time of commissioning, terminating 6 months after the date of commissioning.
   b. Initial issue of allowance list and TBA items during an interval from date of allowance list change, terminating 6 months after the date of the allowance list change.
   c. Initial issue of increased allowed quantities during an interval from the date of authorization for the increased quantity, terminating 6 months after the date of the authorization.
2. Aviation outfitting funds do not support Section C equipment, Section P material and equipment, or any additional required maintenance support tools and equipment not specifically designated as organizational property.

Fleet Outfitting Equipment Funds

Fleet outfitting equipment funds finance the following:

1. Initial issue of special fleet outfittings and reoutfitting of equipment (organizational property) as authorized and directed by the type commander through the administrative commanders.
2. Replacement of the above items if authorized by the type commander.

Temporary Additional Duty Travel Funds

Temporary Additional Duty (TAD) travel funds are provided to finance temporary additional duty travel expenses for personnel attached to type commander aircraft squadrons and units. Expenses financed include the following:

1. Returnable school quotas for aviation unit personnel.
2. Aviation crew rotation.
3. Inspection, logistic support, and other administrative travel by fleet aviation unit personnel.
4. Deployments and emergency leave.
5. Emergency quarters while on extended flight.
6. Storage of household effects while on TAD.

Aviation Maintenance Funds

Aviation maintenance funds finance the cost of NSA (Navy Stock Account), DSA (Defense Supply Agency), GSA (General Services Administration), and open-purchase materials and supplies consumed in the performance of aviation organizational and intermediate maintenance, including the costs of the following:

1. Technical repair parts, common hardware, lubricants, cleaning agents, cutting compounds, metals, etc., incorporated into or expended in the performance of aviation

maintenance of aircraft, aircraft engines, aeronautical components and subassemblies, GSE, and consumable IMRL items.

2. Fuels and lubricants (POL) used in the test, check, and runup of engine or components.

3. Rag or red towel service and cleaning.

4. Preexpended, consumable maintenance material.

5. Replacement of expendable/consumable allowance list items (Material Accountability and Recoverability Codes B and C), including IMRL items.

Fleet Funding

Appropriations for operation and maintenance of the Navy are allocated to each fleet commander for financing supplies and equipage requirements and tender availability. Fleet commanders are responsible for the administration of and accounting for funds allocated to them and must maintain official accounting records and submit reports as required. Fleet commanders issue an allotment to each type commander to finance supplies and equipage requirements and tender availabilities of all ships and flags under his command. (Under the resources management system, this grant is called the expense operating budget.)

A type commander grants authority to ships and commands under his control to cite his allotment for materials and for certain services. This ''obligational authority'' is referred to as operational target or OPTAR.

OPTAR Funds

OPTAR funds are provided each command by the type commander and are controlled by the commanding officer with the supply officer maintaining an accurate record of command expenditures.

Senior AO's aboard ship are concerned with OPTAR in keeping supply records on a divisional level. Normally aviation squadron AO's are not required to keep records of OPTAR expenditures; this service is performed by the material control division for the entire squadron.

Military Requirements for Petty Officer 1 & C, NavPers 10057-C, Chapter 5 (Supply) contains additional information on supply and funding.

DISTRIBUTION SYSTEM

The aviation supply distribution system consists of reserve stock points, primary stock points, secondary stock points, and satellites. These are discussed briefly in the following paragraphs.

1. Reserve Stock Points carry reserve and backup stock for the aviation supply system at reserve stock points. The range and quantity of stock are determined by the Aviation Supply Office. Reserve stock points provide storage facilities for bulk material.

2. Primary Stock Points carry stock for their own consumption. They may be designated as support activities for secondary stock points, for fleet units, and/or yard and district craft in the area.

3. Secondary stock points carry stock for their own consumption as well as stock for aircraft and assigned yard and district craft.

4. Satellites are aviation activities which are dependent for support on a primary or secondary stock point. Satellites are usually minor activities and normally receive their supply support on a retail issue outlet basis.

As far as the consumers are concerned, they may be assigned to any of the primary, secondary, or satellite stock points for supply support. The same basic principles will affect your supply support.

MATERIAL IDENTIFICATION

As part of the aviation maintenance team, the technician will be working closely with the aviation storekeepers in keeping aircraft in an ''up'' status. In order to obtain replacement parts as rapidly as possible, the technician must know how to determine the source of supply of different items. For example, many hours may be wasted trying to find that the item is to be manufactured within the activity. Also, it is important to know the correct stock number and cognizance symbols used to requisition items from supply.

The cataloging system developed by the Department of Defense is such that it identifies with one name and stock number any item of supply that is carried in any or all government agencies. In the procurement of material it is normally necessary to identify your material requirement in the medium understandable to the supply system.

FEDERAL STOCK NUMBERS

Prior to 1952 each of the services had its own numbering system for identifying, cataloging, stocking, and issuing items of military supply. It was not unheard of that one service would be negotiating on the open market for an item that was held in surplus by another service under its own stock number. This confusion resulted in the passage in 1952 of the Defense Cataloging Standardization Act.

The implementation of this Act has resulted in a reduction of item duplication between the services by providing for one Federal Stock Number (FSN) for each item, regardless of the use of the item or the using activity.

Coded Federal Stock Number

The federal stock number consists of an 11-digit number. The Aviation Supply Office uses federal stock numbers with prefixes composed of one, two, or three symbols, and suffixes composed of four characters which may be all letters or a combination of letters and numbers. When the prefixes and suffixes are used, the federal stock number becomes a coded federal stock number. A coded federal stock number and its breakdown is shown in table 3-1.

If a 1-symbol prefix is used, it designates the command or office having control or cognizance of a particular item. Listed below are some of the more common cognizance symbols, together with the type material controlled and the name of the cognizant command or office.

SYMBOL	COGNIZANT ACTIVITY	MATERIAL CONTROLLED
2R	Aviation Supply Office	Aeronautical material
2V	Naval Air Systems Command	Major aeronautical equipment
1I	Navy Supply Depot, Philadelphia	Forms
0I	Navy Supply Depot, Philadelphia	Publications

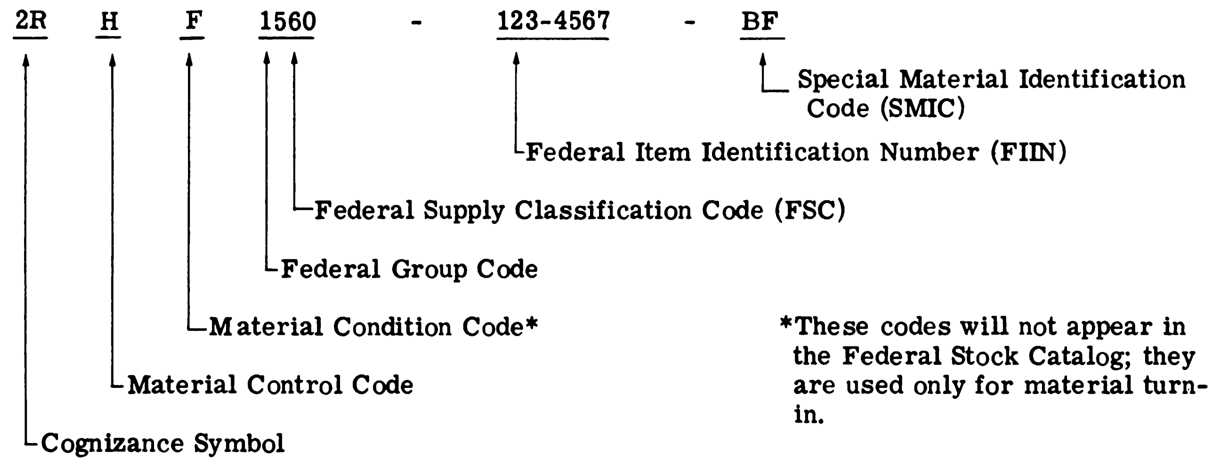
Many variations of coded stock numbers will be encountered in field maintenance work. These variations indicate material management responsibilities for the item; flag certain items as recoverable, consumable, high value, etc.; and identify the condition of the material if it is not ready for issue. Some of the more common codes that an AO is likely to encounter include the following:

RH—a recoverable aeronautical component of high value.

2RHF—a recoverable aeronautical component of high value that is not ready for issue.

Because the variety of codes is so extensive and the trend to single service management of items has caused so many changes in recent years, a list of codes that might be prefixed or suffixed to a stock number would not be appropriate for this manual. The primary things to keep in mind are that the basic stock number, consisting of three groups of numerals,

Table 3-1.—Breakdown of a coded federal stock number.


2R
H
F
1560
-
123-4567
-
BF
Special Material Identification Code (SMIC)
Federal Item Identification Number (FIIN)
Federal Supply Classification Code (FSC)
Federal Group Code
Material Condition Code*
Material Control Code
Cognizance Symbol

*These codes will not appear in the Federal Stock Catalog; they are used only for material turn-in.

identifies the item from a technical point of view and that the other codes identify material management characteristics.

With the advent of the single manager concept, many items formally carried in the individual Navy Stock Lists are cataloged in the Federal Supply Catalog for General Supplies. The complete catalog consists of many sections and is arranged by federal supply classification class.

MATERIAL IDENTIFICATION AIDS

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity is not positively known. A knowledge of the several methods by which material may be identified is very helpful in speeding the completion of a maintenance task. There are many ways in which material may be identified. Certain data may be available which does not identify an item but may lead to positive identification. An aircraft part has a part number. The part number may be looked up in the IPB and identified by nomenclature and often by the stock number. If the stock number is not furnished in the IPB, it may be found by referring to the Cross-Reference Section C0006 of the Navy Stock List of ASO.

Some equipments have attached nameplates which provide such information as the manufacturer's name, make or model number, serial number, size, voltage, phase, etc. Identification data taken from the nameplate of the old part can be very helpful in procuring a replacement.

When only the description of the item is known, the best source for identification is the descriptive sections of the various Navy Stock Lists.

Various publications used in identifying material are described in the following paragraphs.

NAVSUP PUBLICATION 2002, SECTION VIII, PARTS C and D, contains a complete numerical listing of all available naval aeronautic publications distributed by Naval Air Systems Command. This stock list is supplemented by and should be used in conjunction with NavAir 00-500A, Equipment and Subject Applicability List, and NavAir 00-500B, Aircraft Application List. These lists are handy references to publications that should assist you in the identification of material.

ILLUSTRATED PARTS BREAKDOWN (IPB) lists are probably the most important tool for the identification of aeronautical material. As a senior Petty Officer, you are undoubtedly familiar with them. However, due to the importance attached to them as a material identification source, they are discussed briefly in the following paragraphs.

IPB's are compiled by the manufacturer for each aircraft model in naval use. IPB's as discussed here, encompass IPB's for aircraft, IPB's for aircraft engines, and IPB's for individual accessories and equipments.

Although slight variations in format exist among the various IPB's each normally includes the following major sections:

I. TABLE OF CONTENTS—This section shows the breakdown of the catalog into sections and furnishes a cross-reference between the various assemblies and figures where they are illustrated. The section also cross-references assemblies and pages where they are broken down into subassemblies and parts.

II. INTRODUCTION—This section includes general information and instructions for using the publication. Because variations between IPB's do exist, this section should be reffered to prior to using an IPB with which you are not thoroughly familiar.

III. GROUP ASSEMBLY PARTS LIST—This section is the main text of the publication. It consists of a series of illustrations and parts lists in which all parts of the aircraft/engine/equipment are shown in assembly breakdown order. The illustrations and parts lists are keyed to each other by means of figure and index numbers. Each assembly included in the parts lists is followed immediately by its component parts properly indented to show their relationship to the assembly. The group assembly parts lists is subdivided into groups such as wing group, tail group, and fuselage.

IV. NUMERICAL INDEX—This section lists all parts in alphanumerical order, and each part is cross-referenced to the figure and index number where it is illustrated. This list also shows the official source code of each part listed in the applicable IPB.

Source codes are codes which indicate to a consumer a source for a part required in the maintenance of repair of an aeronautical article. They are provided in six series-P, M, A, N, X, and U.

The REFERENCE DESIGNATOR INDEX, normally the last section of the IPB, is a listing of reference designators (C104, R603, K202, etc.) used on the electrical and electronic wiring diagrams. The reference designator index will aid in the location of parts where only the reference designation number is known.

Source code P series parts are parts of supply system stock which are purchased.

Source code M series applies to parts which are not purchased but are capable of being manufactured at Navy fleet or overhaul activities (MF, MO, or MOA).

Source code A series applies to assemblies which are not purchased.

Source code N applies to nonstock items which are purchased on demand.

Source code X applies to main structural members or similar parts, which, if required, would suggest extensive repair. The need for a part or parts coded X normally results in a recommendation for complete overhaul or retirement of the equipment from service.

Source code X1 applies to items for which purchase of the next larger assembly, source coded in the P series, is justified.

Source code X2 is applied to items which are not purchased for stock, but may be acquired for use through salvage or one-time purchase. Activities requiring such items should attempt to obtain them from salvage; if not obtainable from salvage or readily manufactured, such items may then be requisitioned through normal supply channels with supporting justification. Repeated requisitions could justify a change to the P series code.

Source code U applies to parts which are not of supply or maintenance significance, such as installation drawings, diagrams, instruction sheets, etc.

Within each of the source code series listed above there are one or more subcodes identified by a letter or number appended to the basic code letter. These subcodes provide detailed information concerning the procurement or manufacture of various parts within the scope of the particular code series. The introduction section of the applicable IPB provides a ready reference for each of the codes and subcodes as required.

AERONAUTICAL ALLOWANCE LISTS

This title is inclusive of publications identified as Allowance Lists (except advanced base lists), Initial Outfitting Lists, and Tables of Basic Allowances.

PURPOSE AND ORIGIN

Aeronautical Allowance Lists are prepared by the Naval Air Systems Command or by activities as designated and directed by this command. These lists contain the following:

1. The equipment and material (both consumable and nonconsumable) necessary to outfit and maintain units of the aeronautical organization in a condition of material readiness.
2. Substantially all items used with sufficient frequency to justify their issuance to all activities maintaining aircraft or equipment for which the lists are designed.
3. Information concerning stock number, nomenclature, interchangeability, and supersedures.
4. A set of detailed instructions for the application and utilization of the publication.
5. A table of logistic data showing the total weight and cube of all material contained in the lists.

In the final analysis, Aeronautical Allowance Lists are lists of equipment and material determined from known or estimated requirements as necessary to place and maintain aeronautical activities in a condition of material readiness.

Aeronautical Allowance Lists are reissued in accordance with reissue cycles established by the Naval Air Systems Command, or sooner, if required. Interim to reissues, the lists are maintained current by letters and by the issuance of Change Pages and Change Bulletins. Change Bulletins, which are official publications, are issued by ASO on a monthly basis, are numbered in consecutive numerical sequence within each calendar year, and are distributed to holders of allowance lists. For checkoff purposes, a Change Bulletin Index is also published by ASO semiannually and distributed in the same manner as the Change Bulletins.

CATEGORIES

Allowance Lists

These are publications which indicate the range and quantities of equipment and material considered necessary for maintenance support of assigned and/or supported aircraft. Generally, these items are inuse items required for daily or continual use, such as aircraft jacks, air compressors, and avionics/armament test equipment.

Outfitting Lists

Outfitting Lists are publications which indicate the range and quantities of maintenance spare parts considered necessary to support various aeronautical end items. This material is provided to vessels or activities and is firm only at the time of initial outfitting. Increases and decreases in both range and/or quantities of material are based on the experience (usage data) of each activity concerned. Each series list is designed to support an aircraft, electronic equipment, or some other aeronautical end item. The allowances of material are established for various end items for a 90-day period. Not all items capable of replacement by a maintenance activity are listed, but rather, only those that are expected to be used at least once in a 90-day period.

Tables of Basic Allowance

Publications listing equipment and material required for performance of specific functions are known as Tables of Basic Allowance. They contain both shop equipment and common supporting spare parts. They cover allowances of tools and equipment required for use by such activities as Fleet Marine Force squadrons and guided missile activities.

TYPES AND IDENTIFICATION

Initial Outfitting Lists and Allowance Lists are identified by the publication number NavAir 00-35Q series, while Tables of Basic Allowance are identified by publication number NavAir 00-35T series. Senior AO's would normally use the following NavAir Initial Outfitting and Allowance Lists.

Section A, Standard Aeronautical Material and Naval Stock Account Material

Section A covers general material such as nuts, bolts, tubing, hose, paint, and other items common to the operation of all aircraft models. Both equipage and consumable supplies are shown. Quantities of consumable supplies appearing in section A are firm for initial outfitting and may be used as a guide for replenishment until sufficient usage data are available for determining requirements.

Section B, Aircraft Maintenance Parts

Section B contains airframe, engine, and accessories maintenance parts peculiar to each type of aircraft. A separate section B is issued for each model of aircraft. Quantities of items included in this section are the amounts estimated to be required for a given period of time (normally 90 days). Quantities of items appearing in the section B are firm allowances for outfitting only, and are used as a guide for replenishment until such time that sufficient usage data are available for determining requirements. Publication number example: NW-00-35QB-187, Initial Outfitting List for P-3A.

Section BR, Target Aircraft Drone Helicopter, and Guided Missile Maintenance Parts

This series lists maintenance parts (airframe, engine, accessories, and electronics) required for support of the above mentioned vehicles. It is prepared in lieu of a separate section B for airframe, engine, and accessories, and a section R list for electronics parts due to limited installation of electronic equipment. An example is NavAir 00-35QBR-9, concerning AGM-12A and AGM-12B missiles.

Section G, General Support Equipment for All Types, Classes, and Models of Aircraft

Section G (series) lists the quantities of handtools, handling and servicing equipment, and material which are made available for maintenance support of aircraft as may be assigned or supported.

Section K, Naval Aeronautical Publications and Forms

Section K outlines the general types and classes of aeronautical technical and training publications and forms which are provided as a commissioning allowance for various Navy and Marine Corps aviation activities. It lists those publications and forms which are issued by the Deputy Chief of Naval Operations (Air) and by the Naval Air Systems Command, but does not include publications provided to aviation activities by other Navy Department systems commands and bureaus, by fleet commands, or by non-Navy offices.

Section R, Aeronautical Electronic Material List

This section comprises allowance lists of electronic equipment and material required for the test and maintenance of aeronautical electronic/armament equipments within the Naval Establishment.

Section T, Special Maintenance Support Equipment

Section T is applicable to Navy and Marine Aeronautical maintenance activities and lists the allowances of special support equipment required for maintenance support of assigned aircraft. A separate section T allowance is published for each aircraft manufacturer.

The foregoing section list breakdown includes only those sections of professional interest to Aviation Ordnancemen. The complete list includes allowance lists for catapults, arresting gear, photographic materials, aerological equipment, etc.

MATERIAL REQUISITIONING

Maintenance personnel are apt to encounter a variety of local requisitioning channels; all designed to present a demand for an item to the supporting supply department. Assigned levels of maintenance, geographical location of shops relative to supply facilities, and mission of activities requiring support all influence the local requisitioning channels. Local instructions normally promulgate detailed procedures for submitting your demand to the appropriate supply point.

SUPPLY ACTIVITY

The mission of the supply activity is to support the operational and maintenance efforts of the activity/ship. Stocks of aviation oriented material carried are tailored and replenished to this end. Positioning, replenishment, and control of stock of material in maintenance areas are carried out as a result of joint decisions by the Supply and Maintenance Officers concerned. They determine the range, depth, and related procedures. The Navy Maintenance and Material Management System (Aviation) requires that the cost of material used in maintenance be determined and accumulated in such manner and detail that weapons system costing can be measured. Usage is finely defined as to stock number, within component, within equipment/weapon/aircraft, in a particular squadron, located in a specific operational area, at a definite point in time. These data are used as an inventory management tool to determine geographic and strategic distribution of stocks of material. In addition, the data will be invaluable in establishing the material portions of work standards in maintenance.

Supply Support Center

Maintenance organizations have one single point of contact with the supporting supply activity. This single supply contact point is the Supply Support Center (SSC) which responds to all material requirements of the maintenance organizations. The SSC is an internal organization of the local supply activity. It is made up of two sections—the Supply Response Section, (SRS) and the Component Control Section (CCS).

Supply support is available consistent with the operating hours of the maintenance activities supported. If maintenance is being performed 24 hours a day, then supply support is available 24 hours a day.

The supply support center maintains rotatable pool material which consists of repairable ready-for-issue items reserved primarily to satisfy the requirements of organizational level maintenance. Items maintained in the pool are capable of being repaired by the local intermediate maintenance activity, have application relationship to weapon systems supported by local intermediate maintenance activities, and have an average organizational maintenance level removal rate of at least one per month. Defective components are turned in to intermediate level maintenance for repair. The defective components repaired to an RFI condition are then returned to the rotatable pool to replace the components previously issued.

Low value, fast moving consumable items are preexpended from supply. Such materials are located in the maintenance area. The establishment, maintenance, and replenishment of preexpended bins are the responsibility of the supply organization.

SUPPLY RESPONSE SECTION.—The Supply Response Section (SRS) is responsible for preparing all necessary requisitions (DD Form 1348) and related documents required to obtain material for local maintenance use in direct support of weapon system maintenance. The maintenance organization verbally notifies the supply organization of the need for such material. When material is available locally, the time frame for processing and delivery is as follows:

Priority	Process/Delivery Time
1-3	1 hour NORS/NFE
4-8	2 hours
9-20	24 hours

Otherwise, the time frames as noted in table 3-2 will apply.

Table 3-2.—Processing time frames.

Issue Group	Issue Priority Designator Range	Supply Source Processing	CONUS On Station Time	Overseas On Station Time
1	1-3	24-day workweek 24-hour day 7-day workweek	120 hours	168 hours
2	4-8	72 hours 24-hour day 7-day workweek	8 days	15 days
3	9-15	10 days 8-hour day 5-day workweek	20 days	45 days
4	16-20	12 days 8-hour day 5-day workweek	30 days	60 days

The SRS is responsible for receipt, storage, and issuance of all ready-for-issue pool components. It is responsible for physical delivery of RFI material to maintenance organizations, and the pickup of defective components from the organizational maintenance activity and subsequent delivery to the intermediate maintenance activity. Actual maintenance personnel are not involved in the physical movement of material between organizations.

This section also performs technical research in regard to completion of requisition documents as well as determining the status of outstanding requisitions and relaying this status to the customer upon request.

COMPONENT CONTROL SECTION.—The Component Control Section (CCS) accounts for all components being processed in the intermediate maintenance activities. This section also records on the status of all rotatable pool components.

MATERIAL CONTROL DIVISION

The material control division at the organizational level is responsible for providing support and services to the production divisions as follows:

1. Requisition and expedite materials required to support the command.

2. Initiate surveys in the event of loss, damage, or destruction of accountable material/equipment.
3. Verify NORS (Not Operationally Ready Supply) requisitions.
4. Maintain accountability of material authorized by the allowance lists, IMRL's, etc.
5. Establish pickup and delivery points for material.
6. Maintain the material control register or facsimile.
7. Perform cost and allotment accounting.
8. Maintain aircraft inventory logs.
9. Pass all requirements for material required for direct support of weapon system maintenance to the SSC. A Material Control Register is maintained for these items.
10. Prepare documents for material required for indirect support of weapon systems maintenance. Examples of materials for which documents are to be prepared are aviation fuels and lube oils, rags, and flight jackets. A separate requisition record log is maintained for these items.
11. Maintain liaison with the supporting SSC on maintenance material matters to insure that material needs of the organization are satisfied.
12. Furnish technical advice and information to the supply activity on the identity and quantity of supplies, spare parts, and materials, required for maintenance actions.
13. Establish procedures to insure the periodic inventory of tools and the adequate accountability of material and equipment on custody to the cognizant organization.
14. Keep maintenance control advised of the overall supply situation as it affects the activity.

Material control is responsible for the coordination of material ordering, receipt, and delivery. This is done in such a manner as to insure that the correct material is ordered and that is reaches the work center within the specified time frame.

MATERIAL CONTROL REGISTER

The Material Control Register is used by intermediate and organizational level activities to record all materials requested from the supply support center in direct support of weapon system maintenance. Space is provided to record essential information considered necessary to monitor OPTAR funds. This information includes part number, priority, quantity, price, date, and time ordered, and date and time received. Maintenance control uses the time ordered and time received to help determine NORS time used in fulfilling readiness reporting requirements.

When a defective repairable item is turned in, the following forms are required; copies two, three, and four of the multicopy MAF and the Schedule Removal Component Form, OpNav 4790/27A, when applicable. The supply department uses copy two of the MAF for bookkeeping purposes. Copies three and four of the MAF accompany the item to the AIMD. When repair is completed by the AIMD, copy four of the MAF is attached to the RFI item and the item is returned to the supply system.

If material being turned in is no longer required and is RFI, a Single Line Item Release/Receipt Document (DD 1348-1) is submitted with the item. RFI means ready for issue in all respects—preservation still intact and item in original or reusable container with seals unbroken.

MILSTRIP

The Military Standard Requisitioning and Issue Procedure (MILSTRIP) and Uniform Material Issue Priority System were developed by the Department of Defense to provide a common supply language and more effective supply system operations within the military establishment. This system standardizes forms, formats, codes, procedures, and the priority system.

MILSTRIP employs two forms for the requisitioning and issuing of material. The Single Line Item Requisition Document (Form DD 1348) is the basic request document submitted to the applicable supply echelon for material requirements. The issue document is the Single Line Item Release/Receipt Document (Form DD 1348-1). Form DD 1348-1 is also used to return RFI material to the supply system. These forms will be prepared by the Supply Response Section of supply for all material requested in direct support of weapon system maintenance and by the material control division for material requested in indirect support of weapon system maintenance.

Uniform Material Movement and Issue Priority System (UMMIPS)

In this system, the priority designator is determined by a combination of factors which relate the military importance of the requisitioner (force/activity designator) and the urgency of need or end use (indicated by an urgency-of-need designator). The force/activity designator (a roman numeral I-V) is assigned by the Joint Chiefs of Staff (JCS), Chief of Naval Operations (CNO), and Navy commanders. The urgency-of-need designator (an alphabetical letter) is determined by the requisitioning activity, with certain exceptions. These two factors will enable the requisitioning activity to determine the UMMIPS priority designator (arabic numeral).

The twenty priority designators provided in UMMIPS have been placed into four priority groups. Each priority group qualifies for different processing time standards as prescribed in table 3-2. These priority groups are compatible with the transportation priorities prescribed in the Military Standard Transportation and Movement Procedures (MILSTAMP).

1. Force/activity designators.

a. A force/activity is:

(1) A unit, organization, or installation performing a function or mission.

(2) A body of troops, ships, or aircraft, or a combination thereof.

(3) A function, mission, project, or program, including those under military assistance (grant aid and/or sales).

2. Selection and assignment of issue priority designators for requisition and issue transactions.

a. All requests for material normally stocked in a supply system will be assigned an issue priority designator. The issue priority designator normally expresses the relationship between the force/activity designator and the urgency-of-need designator. However, there are certain exceptions and unusual circumstances under which a requisitioning activity is authorized to assign a specific numerical priority designator that represents a uniform need for an item regardless of the force/activity designator assigned. These exceptions are as follows:

(1) A priority designator of 03 will be used by all activities regardless of force/activity designator in requisitioning high value items required for immediate use; i.e., where urgency-of-need designators A or B are indicated.

(2) A priority designator of 03 will be used by all activities, regardless of force/activity designator, for medical or disaster supplies or equipment required immediately for prolonging life in case of critical injury, fatal disease, or natural emergency.

(3) A priority designator of 06 will be used by all activities, regardless of force/activity designator for the replenishment of high value items.

(4) A priority designator of 06 will be used by all activities regardless of force/activity designator, for individual and organizational clothing required to provide a minimum of essential clothing in the event active duty military personnel are without the clothing required.

b. Except for conditions referenced above, the requisitioner will:

(1) Select the applicable urgency-of-need designator for each requisition or order.

(2) Ascertain the appropriate issue priority designator for the force/activity designator assigned the requisitioning activity and the applicable urgency-of-need code, and enter this number on the material requirement document (NAVSTRIP requisition).

c. Supply activities, when requisitioning a specific requirement for a supported unit with a different force/activity designator than the supplying activity, will use the priority designator appropriate to the requiring activity.

3. Every activity is assigned 1 of 5 force/activity designations according to their military importance. (See table 3-3.)

Table 3-3.—Priority number chart.

Designator	A Unable to perform	B Impairs capability	C Other than routine	D Routine
I Combat	1	4	11	16
II Positioned	2	5	12	17
III Ready	3	6	13	18
IV Reserve and support	7	9	14	19
V Others	8	10	15	20

These designators are as follows:

I - COMBAT—The highest order of military importance. This designator is not normally used in peacetime unless approved by the President or the Joint Chiefs of Staff.

II - POSITIONED—United States combat, combat ready, and direct combat support forces deployed outside CONUS in specific theaters or areas designated by the Joint Chiefs of Staff and those CONUS forces being maintained in a state of combat readiness for immediate (within 24 hours) deployment or employment.

III - READY—All other United States combat ready and direct combat support forces outside CONUS not included under designator II.

IV - RESERVE AND SUPPORT—U.S. active and selected reserve forces planned for employment in support of approved joint war plans. This category includes training units and units in training for scheduled deployment.

V - OTHERS—All units not otherwise assigned, including administrative/staff type units.

4. The urgency of need for an aircraft spare part or aeronautical material may be determined in accordance with the following designators (A, B, C, and D):

A - Emergency requirements for primary weappons, equipment, and material for immediate use without which the unit concerned is unable to perform assigned operational missions (NORS), or such condition of readiness is imminent. (See notes 1 and 2.)

Material required for immediate installation on or repair of primary weapons and equipment, without which the unit concerned is unable to perform assigned operational missions (NORS), or such condition of readiness is imminent. (See notes 1 and 2.)

Items required for immediate end use in direct support of equipment essential to the operation of aircraft and equipment (e.g., ground support, firefighting, etc.), or such condition of readiness is imminent. (See notes 1 and 2.)

B - Item(s) required for immediate end use, the lack of which is impairing the operational capability of the aircraft or organizational unit concerned. The aircraft or organizational unit concerned can operate only temporarily as an effective unit; assigned operational missions can be accomplished, but with decreased effectiveness and efficiency.

Item(s) required for immediate end use to effect repairs to aircraft and aircraft support equipment, without which the operational capability of the aircraft is impaired or effectiveness in accomplishing assigned missions is reduced.

Item(s) required to effect emergency repair or replacement of intermediate maintenance activity equipment essential to providing services for aircraft and aircraft equipment.

C - Items required for immediate end use to repair or replace administrative support equipment and equipment or systems not essential to operational missions of aircraft or organizational units.

Items essential to initial outfitting or to completion of allowance/load lists on a more urgent basis than routine stock replenishment.

Material required to preclude a work stoppage or prevent delay in scheduled maintenance of weapons systems or major equipment.

D - Items required for routine stock replenishment.

Items required for initial outfitting and filling of allowances.

Items required for scheduling maintenance, repair, or manufacture of supply system stocks.

NOTE 1: Requirements of this nature are of such a consequence as to require a report to higher authority of a degradation of the requisitioning units capability.

NOTE 2: An imminent condition of degraded readiness exists when material is required to prevent an Anticipated Not Operationally Ready Supply (ANORS) condition. An ANORS condition will exist when it is known that items of material or equipment, not available in the unit, are required within the following time frames:

a. Five (5) days for nondeployed units.

b. Seven (7) days for deployment units.

c. Fifteen (15) days for Vietnam requirements.

PARTS KITS

Parts kits contain supporting items and material for the maintenance, repair, and rework of selected aeronautical repairable type items and will be procured, stocked, requisitioned, accounted for, and used on a kit basis as one line item.

A parts kit consists of a group of maintenance or overhaul parts that are bought, packaged, and stocklisted as a single item regardless of classification that may be included therein. Normally, these parts have either a very low unit cost or have a high replacement rate in overhaul or repair of the next higher assembly. Depending on the complexity of the end item, there can be one or more kits needed for its repair. Parts kits are designed to serve three separate requirements as described in the following paragraphs.

C KIT (CURE-DATED OR SOFT GOODS). This kit provides cure-dated items such as diaphragms, packing, and O-rings. The C kit may also contain soft goods not subjected to age control such as gaskets and seals, plus metallic items such as screws, nuts, and washers required to be removed when cure-dated or soft goods type materials are replaced. Any metallic item placed in the C kit is not duplicated in the D kit. When mixed categories or cure-dated parts are packaged in a single container, the control or cure-date of the package must be that of the oldest cure-dated part contained therein. If cure-dated kits become overaged due to the expiration of the storage limitations, the kit must be administratively disposed of as excess material.

D KIT (OVERHAUL). This kit provides hard good spare parts required for overhaul of equipment by depot level maintenance. This kit does not contain cure-dated parts.

F KIT (FIELD). This kit provides those items that are required to be replaced at intermediate and organizational maintenance levels. These parts are normally items not requiring special tools or equipment. This kit does not contain cure-dated parts.

Part numbers for applicable parts kits for intermediate and organizational levels of maintenance are listed in the Illustrated Parts Breakdown and the Maintenance Instructions Manual. Components of kits are additionally identified in the Illustrated Parts Breakdown by a footnote and a symbol appearing to the right in the part number column and indicating which items are furnished in the kit. The Maintenance Instructions Manual utilizes a symbol keyed to the illustration to indicate parts furnished in the kit.

Presence of a new part in an applicable parts kit eliminates the necessity of cleaning, inspection, or rework of the equivalent part removed from the assembly being repaired. Removed parts in this category must be administratively condemned. Removed parts not supplied in applicable kits must be handled in accordance with instructions contained in the Maintenance Instructions Manuals.

PREEXPENDED BINS

A preexpended bin is one which contains low cost, high usage items which have already been charged to final expenditure. Many items of small dollar value are used repetitively in the aircraft maintenance program. The accepted practice is to stock these repetitively used items in the immediate maintenance area in a semicontrolled preexpended bin. Preexpended bins are normally established by the supply department in consort with the maintenance activity and are labeled, stocked, and replenished by the supply department. The normal responsibilities of maintenance personnel in this are:

1. Recommending items to be stocked.
2. Supervising the use of the bins to prevent waste, pilferage, and deterioration of the contents to a scrap heap.
3. Insuring that preexpended bins are separate and distinct from the normal "salvage" boxes located in most shops.

Preexpended bins provide repetitively used items to maintenance personnel with the minimum of effort. The material is immediately available to all shop personnel. The bins also provide the supply department with a constant and realistic demand history.

Nonstandard and/or Navy manufactured items may at times be required. These are normally obtained through the normal supply channels as outlined in local directives.

Manufactured items are those items which are source coded in the M series in applicable illustrated parts breakdown lists. Request documents submitted for manufactured items should contain additional reference data such as part number, drawing number, and publication reference, or any other information which would be advantageous in the acquisition of the material.

Nonstandard material (material requiring open purchase) may not be procured when standard stock items are available except when the nonstandard material is considered to be indispensable. When the procurement of nonstandard material is considered essential, the originating request document must contain the following information:

1. A certification that no standard stock material is suitable.
2. A justification for the procurement of the nonstandard material.

ROTATABLE POOLS

Rotatable pools consist of a range of selected components maintained by a specific maintenance activity, on custody from the supporting supply department. The items generally carried in the pool are those required to sustain operations where immediate availability is essential. The range and quantity of items to be carried in the pool are subject to the recommendations of the maintenance activities. The supply department establishes the rotatable pool stock and prescribes detailed procedures for operation and control of the pool.

ACCOUNTING FOR MATERIAL IN USE

Accounting for material does not cease when it is withdrawn from the supply department. It is at this point that the accounting responsibility passes to the applicable maintenance personnel.

AIRCRAFT PARTS

Normally, the accounting for aircraft parts drawn to replace similar defective parts is satisfied when the part is installed on the aircraft. No further custodial records are required. The accounting for materials drawn for general maintenance is satisfied when the material is consumed in the authorized maintenance work. In these cases it is actually the removed defective material that required additional action to insure its accountability from the time it is removed until it is returned to the supply department.

The degree of accountability required for aeronautical material may be ascertained by the material accountability recoverability codes (MARC). Material accountability recoverability codes are a part of the source, maintenance, and recoverability codes which are assigned provisioned items as required by current ASO and BuWeps/NavAir directives. The MARC's appear in the descriptive sections and parts lists sections of the ASO Navy Stock List, NavAir Allowance Lists, and may appear in such other publications as directed by NavAirSysCom. These codes aid personnel to determine the proper method of:

1. Requisitioning material.
2. Accounting for material while in use.
3. Turn-in or disposition of material.
4. Repair or overhaul of material.

The following list defines the various material accountability codes.

B - Exchange Consumables. Code B is applied to items which are consumable or expendable but normally require item-for-item exchange for replacement. Such items may contain precious metals, may be highly pilferable, or may be high cost items.

C - Consumables. Code C is applied to all other consumable or expendable items which do not require item-for-item exchange for replacement.

D - Equipage, Support Type. Code D is applied to end items of support equipment which are economical and practical to repair on a scheduled basis through a major rework activity. Code D items are maintained on a custodial basis and normally require item-for item exchange for replacement.

E - Equipage, Locally Repairable, Support Type. Code E is applied to end items of support equipment which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code E items are maintained on a custody basis and normally require item-for-item exchange for replacement.

R - Equipage. Code R is applied to repairable (except end items of support equipment) items which are economical and practical to repair on a programed basis through a major rework activity. Code R items are maintained on a custody basis in some cases, depending upon the use of the item. These items normally require item-for-item exchange for replacement.

L - Equipage, Locally Repairable. Code L is applied to repairable (except end items of support equipment) items which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code L items are maintained on a custody basis in some cases, depending on the use of the item. They will normally require item-for item exchange for replacement.

Some allowance lists may still be in use which utilize a different accountability code system than MARC. The following equivalents may apply, pending issuance of new publications using the latest material accountability recoverability codes:

MARC	INTERIM	OLD
D	A	A
D	O	A
D	E	AX
R	R	X
B	D	NONE
C	C	C
E	NONE	NONE
L	NONE	NONE

As is apparent upon reviewing the material accountability recoverability codes, the disposition of defective material is largely dependent upon its potential repairability. Codes D, E, R, and L signify that the item is repairable and is required to be returned to the supply system even though it is not RFI. The need for the expeditious handling of prospective repairable material cannot be overemphasized. The repair program is the prime source of supply for many critical high value items. Code C items are normally consumed or are not of a repairable nature and do not require turn-in if non-RFI.

An aeronautical material screening unit is established by all activities assigned the responsibility to perform intermediate level maintenance. The basic responsibility of the screening unit is to screen all defective aeronautical material generated on the station by tenant squadrons and station operating units prior to further processing of the material by the supply system or higher echelons of maintenance. The screening unit determines if such material is within the repair responsibility of local intermediate maintenance activities and, if so, initiates action to effect its local repair.

Normally, the following sequence of events should be followed in the repair of aeronautical material:

1. The using activity should repair the defective item without removal from the aircraft.
2. The using activity should remove the defective item from the aircraft, check, test, and repair it within their assigned responsibilities and replace it on the aircraft.
3. In the event the item requires repair and the time involved is excessive from the operational or readiness point of view, the using activity may draw a replacement item from supply. The defective item should be forwarded to the supporting intermediate maintenance activity's screening unit.
4. This screening unit determines if the item is within the repair responsibility of the intermediate maintenance activity, and, if so, the item is repaired and forwarded to supply as RFI. If not, the item is forwarded to supply as prospective repairable material.

SURVEY

A survey is the procedure required by Navy Regulations when Navy property must be expended in one of the following ways:

1. Condemned as a result of damage, obsolescence, or deterioration.
2. Appraised as a result of loss of utility.
3. Acknowledged as nonexistent as a result of loss or theft, necessitating the expenditure of the accountable material from the records of the holding activity.

The purpose of the survey is to provide a record for the following:

1. An administrative review of the condition of the material, the responsibility therefor, and the recommendation for disposition.
2. An authorization to expend the material from the records on which carried.
3. An authorization to decrease the monetary value in store.
4. An authorization to transfer the material having a sales value from the regular federal group to the property disposal account.

Since a survey involves the recording of the expenditure of material or funds, the supply department of a ship or station or material control division of a squadron is responsible for preparing the smooth survey documents and the distribution of the copies regardless of the department in which it was originated.

TYPES OF SURVEYS

A FORMAL survey is required for those classes of materials or articles so designated by the bureau or office concerned, or when specifically directed by the commanding officer. A formal survey is made by either a commissioned officer or a board of three officers, one of whom (and as many as practicable) must be commissioned officers. The commanding officer appoints officers to serve on survey boards.

Neither the commanding officer, the officer on whose records the material being surveyed is carried, nor the officer charged with the custody of the material being surveyed, may serve on a survey board.

INFORMAL surveys are made by the head of the department having custody of the material to be surveyed. Informal surveys are used in all cases (except flight clothing) when a formal survey is not required or directed by the commanding officer. Lost or missing articles of flight clothing in the custody of naval aviators are surveyed by inserting a brief explanation as to the cause and responsibility for the loss on the DD Form 1348 (6 part) submitted to the supply department for the replacement item. This statement must be approved and signed by the commanding officer of the unit to which the aviator is attached. A formal survey is directed by the commanding officer when circumstances are considered to warrant such action.

Material may be expended without survey on a DD Form 1149 which has been annotated "Loss by survey" and indicating the circumstances of the loss or damage or disposition authority thereon in circumstances including the following:

1. Material is short, damaged, or lost in shipment by commercial carrier, government conveyance, or air or regular parcel post and the value of the loss is less than $10 per bill of lading, cargo document, invoice, or other form of shipping document.
2. The value of material lost as a result of physical deterioration, damage by handling, fire, water, or other similar circumstances is less than $100 per line item.
3. Items determined to be scrap by an inventory manager.
4. Losses less than $100 which are the responsibility of the following shippers:
    1. Defense Supply Agency.
    2. General Services Administration.
    3. Army.
    4. Air Force.

PHASES OF SURVEY PROCEDURES

The survey procedure is composed of the following phases:

1. Request for survey
2. Action by the commanding officer on the request for survey.
3. Preparation of the survey report.
4. Action by the reviewing officer, normally the commanding officer, on the survey report.
5. Expenditure of the material from the records on which carried or transfer to the property disposal account when recommended by the survey report and approved by the reviewing officer.

In many cases, when command policy is well established, certain phases are performed simultaneously. For example, phases 1 and 3 could be completed (if it is known in advance that the CO wants an informal survey) followed by steps 2 and 4, thereby eliminating the double routing of the survey through the CO. This should become clearer as we discuss each of the phases in the following paragraphs.

Request For Survey

The survey request may be originated by any department, division, or section head, or by a designated subordinate as prescribed in local regulations. Normally, the survey request is originated in the department having custody of the material to be surveyed.

ROUGH REQUEST.—The initial survey request will be made in rough on a Survey Request Report and Expenditure (NavSup Form 154) except for material lost or damaged in shipment by commercial carriers. In the latter event, the Discrepancy in Shipment Report (Standard Form 361) is used. NavSup Manual, paragraph 25160-3, gives complete information on this subject. Included on or attached to the initial survey request must be a statement of the opinion of the originator relative to the following:

1. The condition of the material.
2. The cause or condition surrounding the loss, damage, deterioration, or obsolescence of the material.
3. The responsibility for the cause or condition if such can be determined or, if the responsibility cannot be determined the reason why it cannot be determined.
4. A recommended disposition of the material and the action to be taken.

The description of the material should be as complete as possible and should include the serial numbers of the items involved, if applicable. In addition, pertinent references to bureau, command, or office manuals or other directives that specifically require formal survey or special disposition of surveyed material will be made on the initial request. The initial survey request is not considered as the survey report but is used as a guide to the commanding officer in determining the type of survey to be held and as an aid to the surveying officer, board, or head of department in the preparation of the survey report. Figure 3-1 is an example of a rough request for survey.

SMOOTH REQUEST.—As prescribed by local regulations, the initial survey request is forwarded to a designated group or section, normally within the supply department, which is charged with the responsibility for preparing the smooth survey request.

The designated group or section will prepare the smooth survey request on NavSup Form 154 or Standard Form 361 in the number of copies required for distribution (usually the original and six copies; see the paragraph on distribution).

The person submitting the initial rough request for survey signs the original of the smooth request for survey as the originator.

The smooth survey request is prepared from information obtained from the initial survey request supplemented by such information as is available from supply department records. Such information includes the date and the name of the activity from which the material was received, the invoice number, and the value of the material. Figure 3-2 is an example of a smooth survey request.

The statement of the opinion of the originator relative to the condition, cause responsibility, and recommendation is not typed on the smooth survey request. However, this statement is appended to the original of the smooth survey request and labeled "Originator's statement" to prevent its possible confusion with the survey report as prepared by the designated surveying officer, board, or head of department. After preparation, the smooth survey request is forwarded to the commanding officer or his representative for action.

Action by the Commanding Officer

Upon receipt of the smooth survey request, the commanding officer or his representative determines whether a formal or an informal survey is appropriate. This decision is entered in the original copies of the smooth survey request. In the case of formal surveys, the smooth survey request is forwarded to the surveying officer or board as designated by the commanding officer for accomplishment of the survey report section of the Survey Request Report and Expenditure (NavSup Form 154) or the Discrepancy in Shipment Report (Standard Form 361).

In the case of informal surveys, the smooth survey request is forwarded to the head of the department having custody of the material to be surveyed for accomplishment of the survey report section of the NavSup Form 154 or the Standard Form 361. The action by the commanding officer is illustrated in figure 3-3.

Preparation of the Survey Report

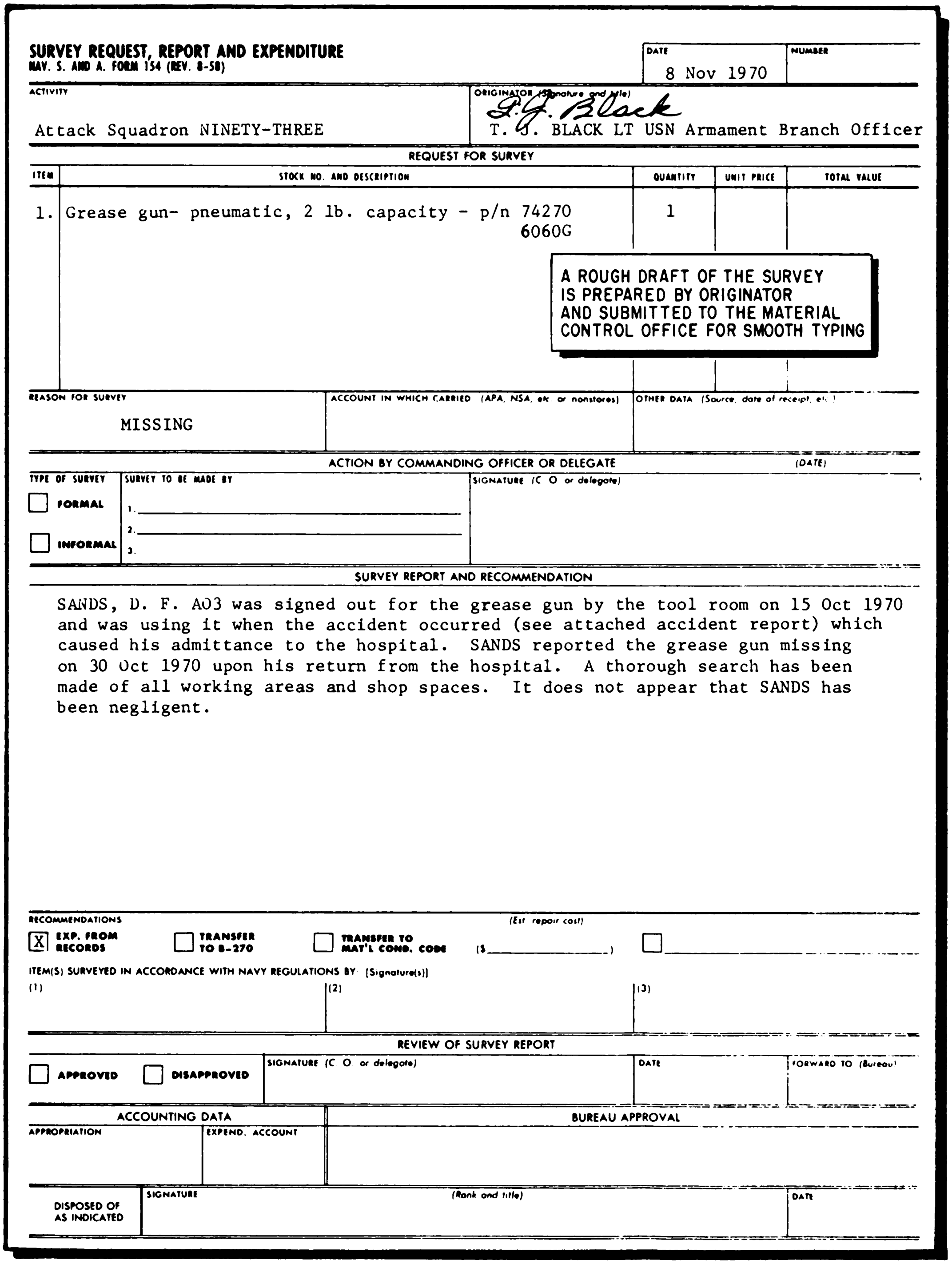
The surveying officer, board, or head of department makes a thorough inspection of the material being surveyed to determine its condition at the time of survey or, if missing, a thorough examination of the circumstances attending the loss, and fixes the cause and responsibility therefor or, when responsibility cannot be fixed, makes a statement showing clearly why such cannot be done.

A full report is made on Survey Request, Report and Expenditure (NavSup Form 154) or on the Discrepancy in Shipment Report (Standard Form 361) in the report section. This report includes the findings as to condition, cause, and responsibility and a recommendation as to disposition, replacement, or continuance in service. The recommendation for disposition must be specific and in accordance with the NavSup Manual, paragraph 25160-4.

The supply department is usually responsible for the smooth preparation of the report section of the survey from information furnished by the surveying officer or board. Figure 3-4 illustrates an example of the completion of the report section. The survey officer or officers sign the report section of the smooth survey which is then forwarded to the commanding officer for review.

Action by the Reviewing Officer

After action by the surveying officer, board, or head of department, the survey report is submitted for review to the commanding officer or the officer ordering the survey, if the survey was ordered by higher authority. When the reviewing officer does not approve the action of the surveying officer, board, or head of department, he causes another survey to be held on the material. In all cases the second survey must be formal. If the reviewing officer does not approve the findings of the second survey, the matter must be referred to the bureau, command, or office having cognizance over the material.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 8 Nov 1970
NUMBER:

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T. J. Black
T. J. BLACK LT USN Armament Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	Grease gun- pneumatic, 2 lb. capacity - p/n 74270 6060G	1		

A ROUGH DRAFT OF THE SURVEY
IS PREPARED BY ORIGINATOR
AND SUBMITTED TO THE MATERIAL
CONTROL OFFICE FOR SMOOTH TYPING

REASON FOR SURVEY: MISSING

ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores):

OTHER DATA (Source, date of receipt, etc.):

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY: ☐ FORMAL ☐ INFORMAL

SURVEY TO BE MADE BY
1. ______
2. ______
3.

SIGNATURE (C. O. or delegate)

SURVEY REPORT AND RECOMMENDATION

SANDS, D. F. AO3 was signed out for the grease gun by the tool room on 15 Oct 1970 and was using it when the accident occurred (see attached accident report) which caused his admittance to the hospital. SANDS reported the grease gun missing on 30 Oct 1970 upon his return from the hospital. A thorough search has been made of all working areas and shop spaces. It does not appear that SANDS has been negligent.

RECOMMENDATIONS
☒ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE (Est repair cost) ($______) ☐ ______

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY [Signature(s)]
(1) (2) (3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED

SIGNATURE (C. O. or delegate)

DATE

FORWARD TO (Bureau)

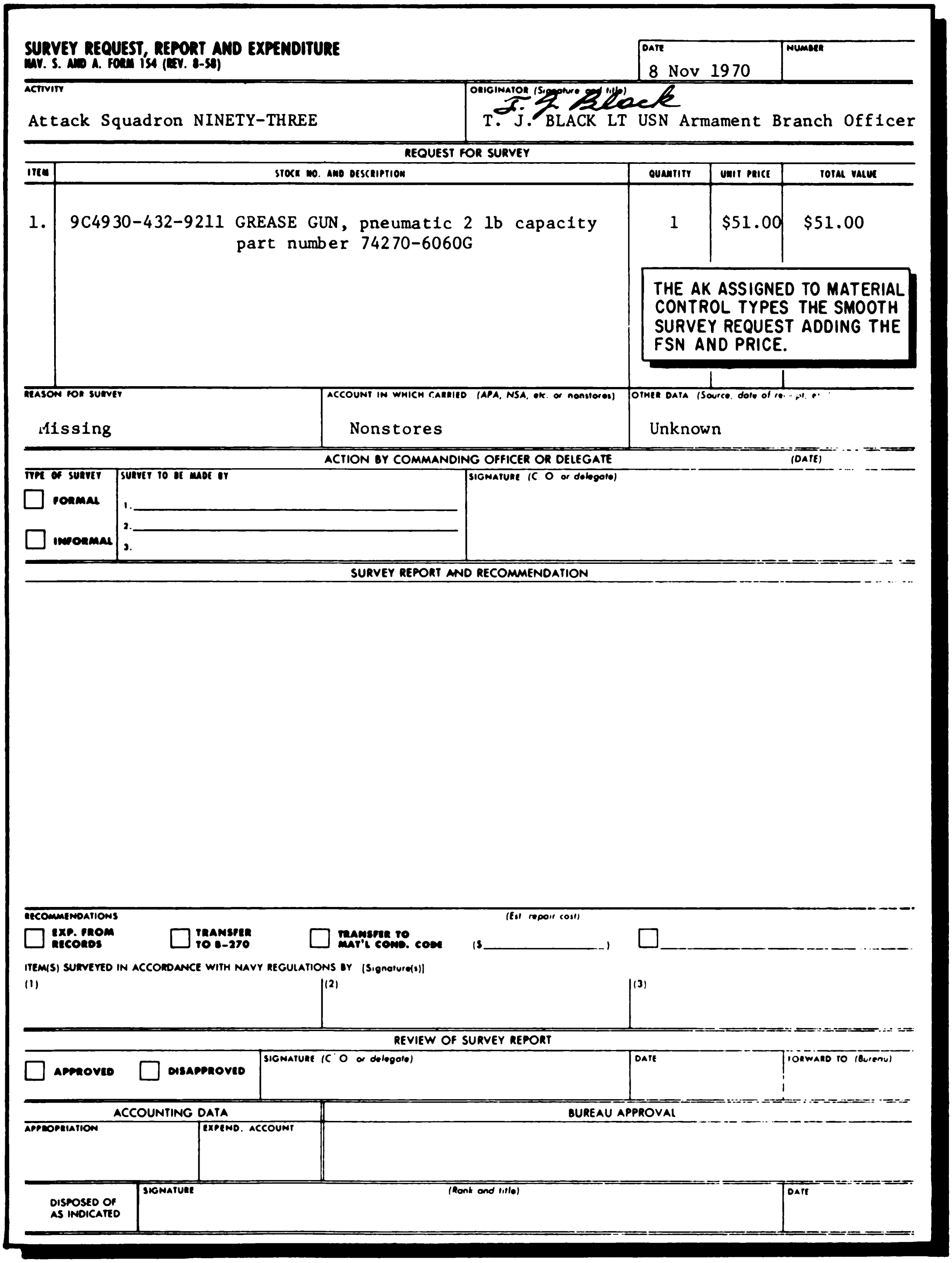
ACCOUNTING DATA
APPROPRIATION
EXPEND. ACCOUNT

BUREAU APPROVAL

DISPOSED OF AS INDICATED
SIGNATURE (Rank and title)
DATE

AO. 497

Figure 3-1.—Rough request for survey.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 8 Nov 1970
NUMBER:

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T. J. Black
T. J. BLACK LT USN Armament Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

THE AK ASSIGNED TO MATERIAL CONTROL TYPES THE SMOOTH SURVEY REQUEST ADDING THE FSN AND PRICE.

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores)	OTHER DATA (Source, date of re
Missing	Nonstores	Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY
☐ FORMAL
☐ INFORMAL

SURVEY TO BE MADE BY
1.
2.
3.

SIGNATURE (C O or delegate)

SURVEY REPORT AND RECOMMENDATION

RECOMMENDATIONS
☐ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE (Est repair cost) ($) ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY (Signature(s))
(1) (2) (3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED SIGNATURE (C O or delegate) DATE FORWARD TO (Bureau)

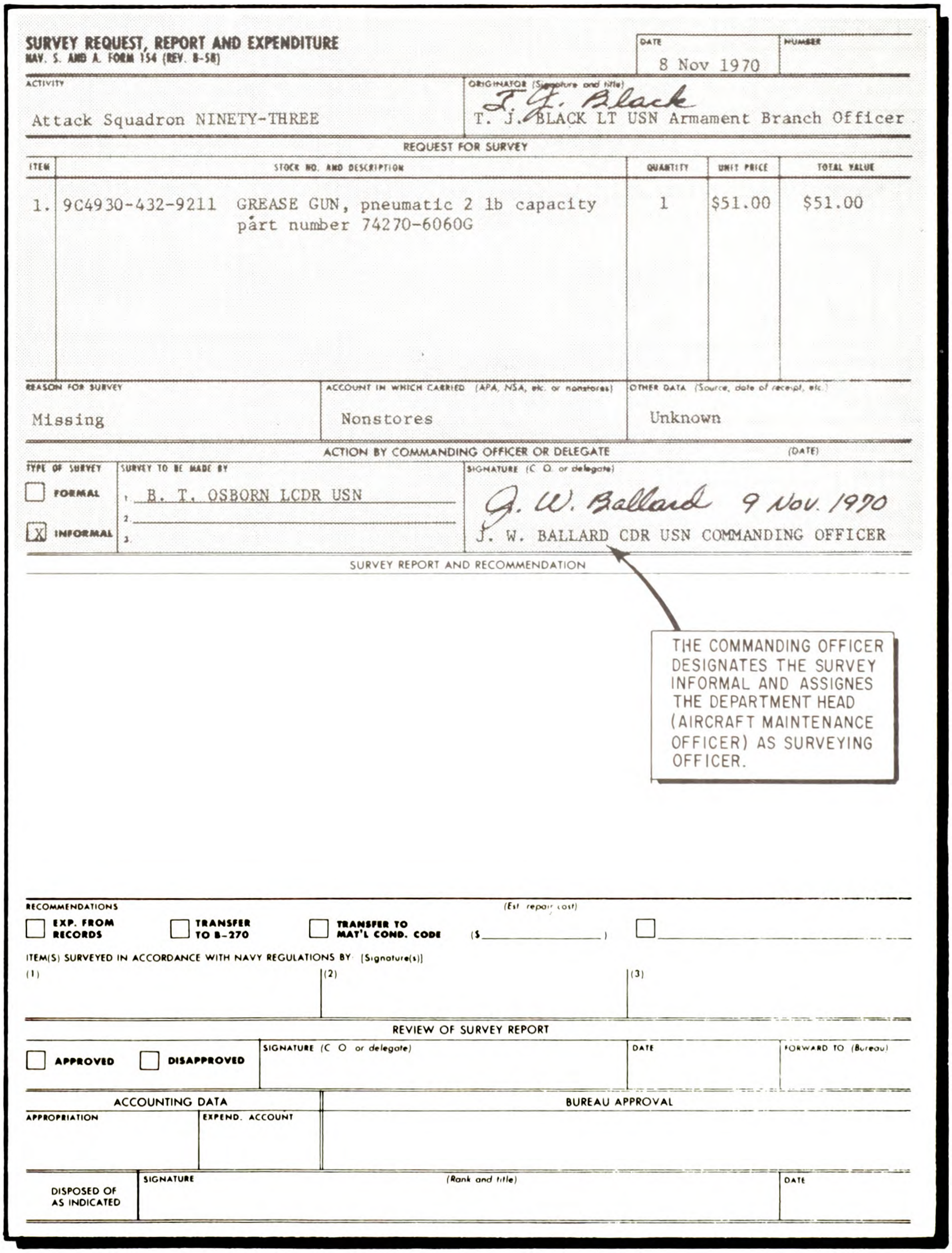
ACCOUNTING DATA
APPROPRIATION EXPEND. ACCOUNT

BUREAU APPROVAL

DISPOSED OF AS INDICATED SIGNATURE (Rank and title) DATE

AO. 498

Figure 3-2.—Smooth survey request.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 8 Nov 1970
NUMBER:

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T. J. Black
T. J. BLACK LT USN Armament Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores)	OTHER DATA (Source, date of receipt, etc.)
Missing	Nonstores	Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY:
☐ FORMAL
☒ INFORMAL

SURVEY TO BE MADE BY:
1. B. T. OSBORN LCDR USN
2.
3.

SIGNATURE (C. O. or delegate): J. W. Ballard 9 Nov. 1970
J. W. BALLARD CDR USN COMMANDING OFFICER

THE COMMANDING OFFICER DESIGNATES THE SURVEY INFORMAL AND ASSIGNES THE DEPARTMENT HEAD (AIRCRAFT MAINTENANCE OFFICER) AS SURVEYING OFFICER.

SURVEY REPORT AND RECOMMENDATION

RECOMMENDATIONS
☐ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE (Est. repair cost) ($ ________) ☐ ________

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: [Signature(s)]
(1)
(2)
(3)

REVIEW OF SURVEY REPORT

☐ APPROVED ☐ DISAPPROVED
SIGNATURE (C. O. or delegate):
DATE:
FORWARD TO (Bureau):

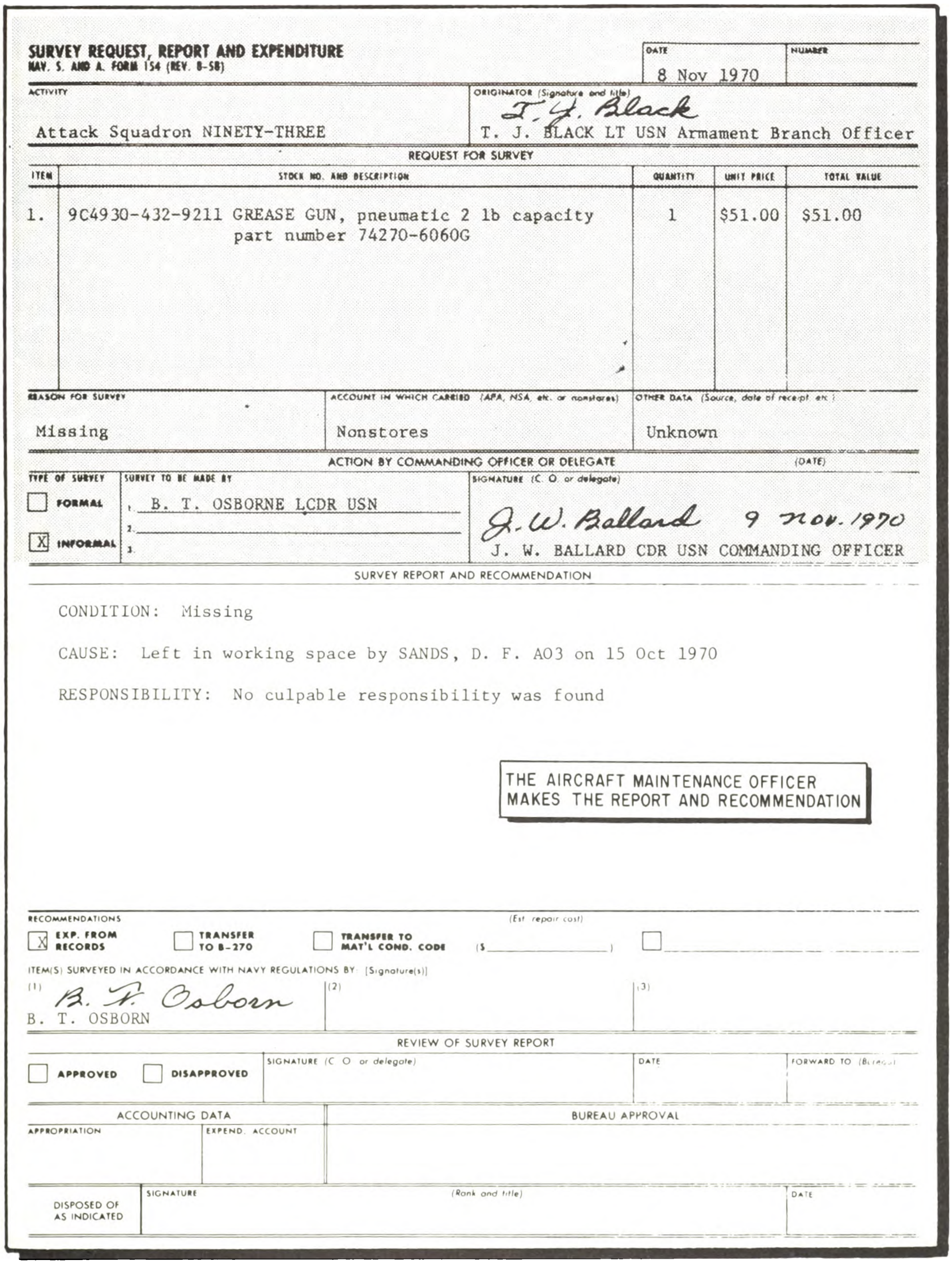
ACCOUNTING DATA
APPROPRIATION:
EXPEND. ACCOUNT:

BUREAU APPROVAL

DISPOSED OF AS INDICATED
SIGNATURE: (Rank and title)
DATE:

AO. 499

Figure 3-3.—Action by the commanding officer on a survey.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE 8 Nov 1970	NUMBER

ACTIVITY Attack Squadron NINETY-THREE	ORIGINATOR (Signature and title) T. J. Black T. J. BLACK LT USN Armament Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

REASON FOR SURVEY Missing	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores) Nonstores	OTHER DATA (Source, date of receipt, etc.) Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY	SURVEY TO BE MADE BY	SIGNATURE (C. O. or delegate)
☐ FORMAL ☒ INFORMAL	1. B. T. OSBORNE LCDR USN 2. 3.	J. W. Ballard 9 Nov. 1970 J. W. BALLARD CDR USN COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

CONDITION: Missing

CAUSE: Left in working space by SANDS, D. F. AO3 on 15 Oct 1970

RESPONSIBILITY: No culpable responsibility was found

THE AIRCRAFT MAINTENANCE OFFICER
MAKES THE REPORT AND RECOMMENDATION

RECOMMENDATIONS

☒ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE (Est repair cost) ($) ☐

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: (Signature(s))

(1) B. T. Osborn B. T. OSBORN	(2)	(3)

REVIEW OF SURVEY REPORT

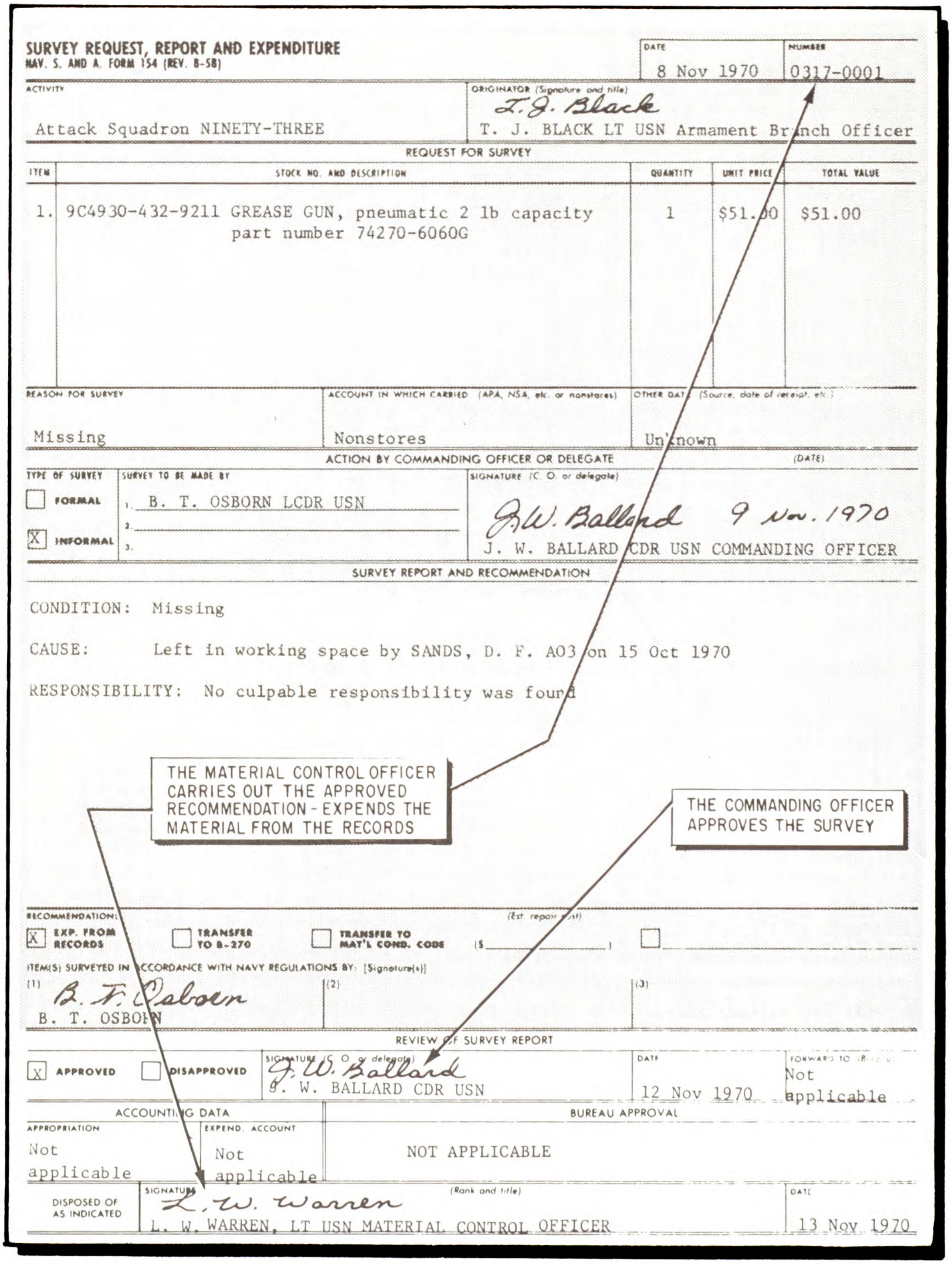
☐ APPROVED ☐ DISAPPROVED	SIGNATURE (C. O. or delegate)	DATE	FORWARD TO (Bureau)

ACCOUNTING DATA		BUREAU APPROVAL
APPROPRIATION	EXPEND. ACCOUNT	

DISPOSED OF AS INDICATED	SIGNATURE (Rank and title)	DATE

AO.500

Figure 3-4.—Completion of Report section of a survey.



SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 8 Nov 1970
NUMBER: 0317-0001

ACTIVITY: Attack Squadron NINETY-THREE

ORIGINATOR (Signature and title): T. J. Black
T. J. BLACK LT USN Armament Branch Officer

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	9C4930-432-9211 GREASE GUN, pneumatic 2 lb capacity part number 74270-6060G	1	$51.00	$51.00

REASON FOR SURVEY: Missing

ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores): Nonstores

OTHER DATA (Source, date of receipt, etc.): Unknown

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE)

TYPE OF SURVEY
☐ FORMAL
☒ INFORMAL

SURVEY TO BE MADE BY
1. B. T. OSBORN LCDR USN
2.
3.

SIGNATURE (C. O. or delegate): J. W. Ballard 9 Nov. 1970
J. W. BALLARD CDR USN COMMANDING OFFICER

SURVEY REPORT AND RECOMMENDATION

CONDITION: Missing

CAUSE: Left in working space by SANDS, D. F. AO3 on 15 Oct 1970

RESPONSIBILITY: No culpable responsibility was found

THE MATERIAL CONTROL OFFICER CARRIES OUT THE APPROVED RECOMMENDATION - EXPENDS THE MATERIAL FROM THE RECORDS

THE COMMANDING OFFICER APPROVES THE SURVEY

RECOMMENDATION:
☒ EXP. FROM RECORDS ☐ TRANSFER TO B-270 ☐ TRANSFER TO MAT'L COND. CODE (Est. repair cost) ($________) ☐ ________

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: (Signature(s))
(1) B. T. Osborn
B. T. OSBORN
(2)
(3)

REVIEW OF SURVEY REPORT

☒ APPROVED ☐ DISAPPROVED

SIGNATURE (C. O. or delegate): J. W. Ballard
J. W. BALLARD CDR USN

DATE: 12 Nov 1970

FORWARD TO: Not applicable

ACCOUNTING DATA
APPROPRIATION: Not applicable
EXPEND. ACCOUNT: Not applicable

BUREAU APPROVAL: NOT APPLICABLE

DISPOSED OF AS INDICATED
SIGNATURE (Rank and title): L. W. Warren
L. W. WARREN, LT USN MATERIAL CONTROL OFFICER

DATE: 13 Nov 1970

AO.501

Figure 3-5.—Completed survey.

Survey Expenditure

Upon receipt of the properly approved Survey Request, Report and Expenditure (NavSup Form 154) or the Discrepancy in Shipment Report (Standard Form 361), the supply officer carrying the surveyed material on his records completes the expenditure section except when the material has disposal value and the material is to be transferred to the property disposal account.

Appropriate expenditure data is entered on the Standard Form 361, and the accounting data or appropriation to which the proceeds of claim action should be ultimately credited is entered in the appropriate item. The NavSup Form 154 or Standard Form 361 is assigned a number in the regular expenditure invoice series. If the material is not to be expended from the records but is to be transferred to the property disposal account, transfer is accomplished on NavSup Form 154 or Standard Form 361 without filling in any part of the expenditure section. Figure 3-5 illustrates an example of the completed survey.

DISTRIBUTION OF SURVEYS

Copies of a survey are distributed by the supply department as follows:

1. One copy to the originator of the survey request.
2. One copy to the surveying officer, board, or head of department.
3. The original and three copies to the supply officer carrying the surveyed material on his records except when the original is forwarded to a systems command or office for approval. (See item 4).
4. The original to the cognizant systems command or office when required for final review and approval. The original is returned to the supply officer carrying the surveyed material on his records unless the systems command or Navy inventory manager requires an information copy approved by the commanding officer. In such cases, a copy is returned to the supply officer carrying the surveyed material on his records.
5. Any additional copies as required by local regulations.
6. One copy to the expenditure file.
7. When commercial shipment is involved, additional copies must be distributed as outlined in the NavSup Manual, paragraphs 25163-6 and -7.

EMERGENCY DISPOSAL

The commanding officer may direct immediate disposition of surveyed material prior to the receipt of systems command or other approval if this action is considered necessary to safeguard the health or safety of his command.

CULPABLE RESPONSIBILITY

When a person in the naval service is found to be culpably responsible by a surveying officer or board, the reviewing officer refers the entire matter to such a person for a statement. The reviewing officer must then take such disciplinary action as the circumstances require. He notes on the survey form the action taken and informs the Chief of Naval Personnel and the systems command concerned as to the disciplinary action taken. In the case of officers, he must make recommendations as to the inclusion of a statement of the action taken in the record of the person concerned and inform such person of the final decision in the matter. Action on the survey in respect to the material involved is not, however, withheld pending disciplinary action.

CHAPTER 4

CARRIER AIRCRAFT ARMAMENT SYSTEMS

This chapter is presented to acquaint the AO with armament systems of the various types of aircraft now operating aboard CVA's. Specific detailed information of the F-4, A-6, and the A-7 aircraft can be found in the NavAirSysCom manuals for each aircraft.

ARMAMENT SYSTEMS

Due to the increased complexity of the present and planned armament systems, the AO supervisor must have a basic understanding of the various types of equipment, maintenance, testing, and configuration of the systems now in use.

Troubleshooting and testing of the armament systems is now performed by team members that have received special training on the type aircraft assigned. This team, Weapons Verification Crew, consists of two AO's, two AE's, two AQ's, and occasionally an AT. With this concept now in the fleet, no attempt will be made in this manual to cover troubleshooting and testing procedures.

A-6 ARMAMENT SYSTEM

The A-6 is a two-place, all-weather attack bomber and has a crew which consists of a pilot and a bombardier/navigator in a side-by-side seating arrangement. The basic armament configuration consists of five external stores stations, two on each wing and one on the fuselage centerline. Each station has fuel, air, and electrical connections for a 300-gallon external fuel tank. The Aero 7A-1 is used on each station (except the centerline where the Aero 7B-1 is used) to carry bombs, rocket launchers, missile launchers, and other stores. In addition, the aircraft armament system is capable of utilizing the Multiple Bomb Rack A/A37B-1, Triple Ejector Rack A/A37B-5, and the Multiple Ejector Rack A/A37B-6.

Provisions exist for mounting an adapter (in place of the Aero 7A-1 ejector rack) on the wing stations which will accept the Guided Missile Launcher LAU 7/A (used for the AIM-9B Sidewinder Missile or the AGM-87A which is a modified AIM-9B for air-to-ground attacks). The Guided Missile Launcher Aero 5A-1 is suspended from the Aero 7A-1 ejector rack on wing stations only and is used for the AGM-12B (Bullpup) and the AGM-45A (Shrike) missiles.

Provisions also exist (on later aircraft bureau numbers) for carrying and firing four Mk 4 Mod 0 gun pods, one on each wing station. Special weapons are carried and released from the two inboard wing stations and fuselage station only. (Refer to NavAir 01-85ADA-13, Supplemental Manual, Special Weapons for the current list of special weapons and accessories that may be carried.) No weapon can be loaded on the A-6 unless full instructions are in the preceding manual and NavAir 01-85AD-75. No weapon can be carried in flight unless cleared for flight in the A-6 NATOPS Tactical Manual, NavAir 01-85ADA-1T.

Detailed information on the operation and troubleshooting of the A-6 armament system can be found in NavAir 01-ADA-2-6.

F-4 ARMAMENT SYSTEM

The F-4 is a two-place carrier aircraft that is capable of fighter/interceptor and bombing roles. The F-4J is the latest model in fleet use and is discussed in this section. Detailed information on the F-4B and F-4J armament systems can be found in NavAir 01-245FBD-2-7.

Missile Launching System

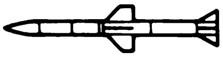
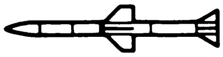
The missile launching system suspends and launches radar and heat seeking missiles in all weather or electronic countermeasure conditions. Four radar missiles (AIM-7) are positioned in tandem pairs in recessed cavities on the bottom of the fuselage. Two additional missile stations are provided by installation of the wing missile pylons. These pylons are capable of carrying one radar missile or two heat seeking (AIM-9) missiles. The AIM-9 missiles are suspended from rail launchers attached to the sides of the wing pylon. The AIM-7 missiles are suspended from a rail on the underside of the same pylon. However, because of missile fin and wing interference, both types of missiles cannot be carried on the pylon at the same time. See figure 4-1 for F-4 aircraft missile capabilities.

Normal missile release is accomplished by the Airborne Missile Control System (AMCS) AN/AWG-10. Refer to NavAir 01-245FDB-2-8.8 for a detailed description of this system. The AN/AWG-10 system consists of the following associated items:

1. Two hydraulic operated cavity doors in each forward missile cavity on some production aircraft; others have one hydraulic operated cavity door in each forward cavity.
2. Four fuselage mounted Aero 7A missile launchers.
3. Two LAU-17/A wing missile pylons.
4. Four wing pylon mounted LAU-7/A missile launcher.

Multiple Weapons Systems

The multiple weapons system equips the aircraft with suspension, release, and firing capabilities for conventional weapons. These weapons comprise general-purpose bombs, rockets, and the MK 4 gun pod. Multiple weapons conversion kits adapt the aircraft for transporting conventional weapons on the outboard wing pylon, LAU-17/A wing missile pylon, and Aero 27A bomb rack

TYPE OF STORE	STATION	TYPE OF SUSPENSION EQUIPMENT	NORMAL RELEASE MODE	EMERGENCY RELEASE MODE
AIM-7D SPARROW III 	LEFT AFT FUSELAGE CAVITY RIGHT FWD FUSELAGE CAVITY LEFT FWD FUSELAGE CAVITY RIGHT AFT FUSELAGE CAVITY	AERO 7A GUIDED MISSILE LAUNCHER	F-4B AIRBORNE MISSILE CONTROL SYSTEM AERO 1A (XN-4)	SELECTIVE MISSILE JETTISON SWITCH OR EXT STORES EMER REL SWITCH
	LEFT INBOARD WING RIGHT INBOARD WING	F-4B LAU-17/A WING MISSILE PYLON F-4J INBOARD MISSILE PYLON	F-4J MISSILE CONTROL SYSTEM AN/AWG-10	
AIM-7E SPARROW III 	LEFT AFT FUSELAGE CAVITY RIGHT FWD FUSELAGE CAVITY LEFT FWD FUSELAGE CAVITY RIGHT AFT FUSELAGE CAVITY	AERO 7A GUIDED MISSILE LAUNCHER	F-4B AIRBORNE MISSILE CONTROL SYSTEM AERO 1A (XN-4)	
	LEFT INBOARD WING RIGHT INBOARD WING	F-4B LAU-17/A WING MISSILE PYLON F-4J INBOARD MISSILE PYLON	F-4J MISSILE CONTROL SYSTEM AN/AWG-10	
AIM-9B SIDEWINDER 	LEFT INBOARD WING RIGHT INBOARD WING	TWO AERO 3A LAUNCHERS ATTACHED TO EITHER SIDE OF THE LAU-17/A WING MISSILE PYLON ON F-4B	AIRBORNE MISSILE CONTROL SYSTEM AERO 1A (XN-4)	
AIM-9D SIDEWINDER 	LEFT INBOARD WING RIGHT INBOARD WING	TWO LAU-7/A LAUNCHERS ATTACH TO EITHER SIDE OF THE LAU-17/A WING MISSILE PYLON ON THE F-4B OR INBOARD MISSILE PYLON ON THE F-4J.	F-4B AIRBORNE MISSILE CONTROL SYSTEM AERO 1A (XN-4) F-4J MISSILE CONTROL SYSTEM AN/AWG-10	

AO.502

Figure 4-1.—F-4 aircraft missile capabilities.

Table 4-1.—F-4 aircraft multiple weapon suspension capabilities.

Conventional weapons	RH outboard	RH inboard	Centerline	LH inboard	LH outboard
Aero-27A ejector rack.			X		
LAU-17/A wing missile pylon (F-4B).		X		X	
Inboard missile pylon (F-4J).		X		X	
Outboard wing pylon.	X				X
Multiple weapon adapter assembly (wing).	X	X		X	X
Multiple weapon adapter assembly (fuselage).			X		
Multiple ejector rack (MER).	X		X		X
Triple ejector rack (TER).		X		X	

at the centerline station. See table 4-1 for weapon suspension capabilities of the multiple weapons system.

Centerline Weapons System

The centerline system provides the aircraft with capabilities for conventional or special weapons and centerline fuel tank. The system incorporates the Aero 27A gas operated ejector bomb rack for suspension and release of all centerline stores. Four internally mounted swaybraces adjacent to the bomb rack and two fin restraint mechanisms mounted in the aft engine doors stabilize the store until released. In-flight release is provided in two electrically controlled modes of operation, emergency release and normal release, each mode having independent 28-volt d-c electrical circuits and controls. Normal release is further divided into DIRECT, for direct selective release of the centerline store, and LABS. In all modes of operation, release is accomplished by electrical impulse, detonating two gas-generating cartridges in the dual breech housing of the bomb rack.

Special weapons are carried only on the centerline Aero 27A bomb rack and do not require conversion kits or modification from the basic delivered configuration. All aircraft are instrumented to carry and deliver special weapons in the timed O/S, instantaneous O/S, loft, or directed modes. The weapons are controlled through the DCU-75/A monitor control panel and the loft bomb release computer set AN/AJB-3A or AN/AJB-7 (AQ's responsibility). Pullout plugs are connected either to one or both of the centerline forward or aft special weapon receptacles. Refer to NavAir 01-245-FDB-2-6.15 for a complete description of the AN/AJB-3A or AN/AJB-7 attitude reference and bomb computer systems.

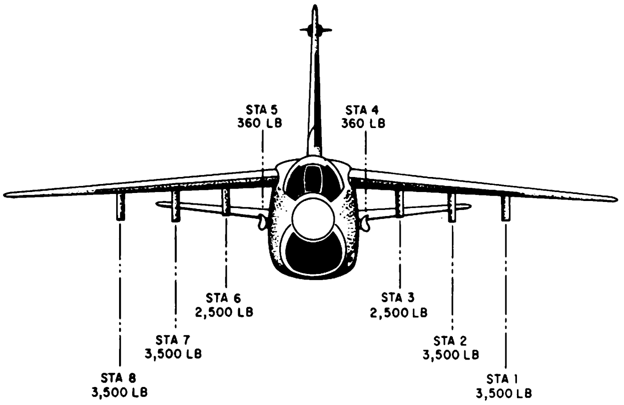
A-7E ARMAMENT SYSTEM

The A-7E is a single-place jet aircraft capable of operating from a carrier or land base. The aircraft is capable of carrying 19,720 pounds of external stores (fig. 4-2) on six wing pylons and two fuselage pylons. It is also equipped with the M61A1 20-mm automatic gun which can fire 4,000 or 6,000 rounds a minute.

Missile capabilities include Sidewinder AIM-9B/D, Shrike AGM-45A, and Walleye AGM-62. The Mk 4 gun pod and KB-18A strike camera are also utilized on the A-7E. For a complete listing of weapons capabilities and station configurations, consult NavAir 01-45AE-75.

FUSELAGE PYLONS

There are two fuselage pylons—armament station 4, located on the left side of the fuselage; and armament station 5, located on the right side of the fuselage. A LAU-7/A guided missile launcher attaches to each pylon. Each launcher



AO.503

Figure 4-2.—External store loading.

can carry one Sidewinder missile. The LAU-7/A contains firing circuits and a nitrogen bottle for IR cooling of the AIM-9D Sidewinder missle. When on the deck, a safety pin is inserted through the detent lock-arm to prevent inadvertent firing.

WING PYLONS

Six pylons are provided for stores carriage on the wings. From left to right, the pylons are numbered 1, 2, and 3 on the left wing and 6, 7, and 8 on the right wing. A BRU 10/A ejector rack is installed on each pylon. All stores or additional racks attach to the BRU 10/A racks.

RU 10/A Ejector Rack

One BRU 10/A ejector rack is installed on each wing pylon. A single store, missile launcher, or a multiple carriage rack is supported by hooks from each BRU 10/A rack. During release of a single store, ejector cartridges open the hooks to release the store and cause an ejector foot to kick the store downward. Jettisoning occurs in the same manner, except that an auxiliary release cartridge serves as a backup for opening the hooks. Thus, if the ejector cartridge misfires during jettisoning, the store is gravity-dropped. One safety pin is used to mechanically safe each rack. The safety pin does not interrupt the electrical release circuit but does prevent the rack from releasing a store. If the rack is inadvertently actuated with the safety pin installed, the impulse cartridges will fire, but gases will be vented overboard and store release will not occur. (The BRU 10/A is a modified MAU 9A/A.)

LAU-10/A, LAU-10A/A
Rocket Launchers

Each launcher holds four Zuni rockets and may be used on all wing stations. The launchers can be single mounted to the BRU-10/A ejector rack or multiple mounted on a TER. The LAU-10/A and LAU-10A/A launchers operate in either single or ripple modes. The mode of operation must be selected before flight. With the mode switch in SINGLE, one rocket will fire from the launcher each time the launcher receives a fire pulse. In RIPPLE, the four rockets will fire with one fire pulse to the launcher. When launchers are mounted on the triple ejector rack and the launcher mode switch is in SINGLE, one rocket will fire from each of the launchers in the TER firing sequence (center, left, right) with each actuation of the Release Enable switch until all launchers receive one fire pulse. With the launcher mode switch in RIPPLE, each launcher is emptied with one actuation of the Release Enable switch in the TER firing sequence (center, left, right). Inadvertent release of the launcher on the ground is prevented by a safety pin installed in the BRU 10/A ejector rack and, when mounted on the TER, by a safety pin in each of the TER station toggle linkages. Inadvertent firing while on the ground is prevented by a safety switch in the forward receptacle of the launcher and the TER electrical switch.

2.75-Inch Rocket Launchers

These launchers are mounted on the TER or on the BRU 10/A rack and are carried on wing stations only. The LAU-32A/A, -56/A, and -68/A hold seven 2.75-inch FFAR rockets and the LAU-3A/A, -60/A, -61/A, and -69/A hold nineteen.

The LAU-56/A, -61/A, -68/A, and -69/A have ripple and single options. The LAU-3A/A, -32A/A, and -60/A have only a ripple intervalometer but can use a SWU-31A switching unit to provide a single option.

When on the ground, inadvertent release of the launcher is prevented by safety pins inserted in the BRU 10/A ejector racks, the TER station toggle linkages, and an electrical safety switch.

Inadvertent firing of the rockets is prevented by a pin inserted in the rocket launcher breaker switch.

A/A37B-5 Triple Ejector Rack (TER)

Triple ejector racks can be used on all wing pylons. One TER can be attached to each BRU 10/A ejector rack. Firing or releasing modes depend upon the prepositioning of TER mounted controls and ASCU switch settings. When the aircraft is on the ground, one safety pin is installed in the rack hook toggle linkage on each of the TER stations, one pin is inserted in the electrical safety switch at the aft end of the TER, and one pin is inserted in the BRU 10/A ejector rack.

The TER operates in three modes: Rocket Normal, CBU, and Auto Ripple. The mode of operation is selected before flight by placing the TER mode switch in the required position and setting the ASCU store type switches. In the ROCKET NORMAL position, one rocket will fire with each fire pulse to the TER in the order of center, left, and right. TER will automatically step through an unloaded rack station, but not through an empty launcher. Each time Master Arm power is supplied to the station, TER will home to the first loaded rack station (only if first station is empty). The sensing switch for automatic stepping is located on the forward suspension hooks of the ejector units. Closing the forward hook willl indicate to the TER that the rack station is loaded.

In the CBU position, one dispenser will fire with each fire pulse to TER in the same order of center, left, right. TER will automatically step through an unloaded rack station but will try to fire an empty dispenser. Normal bomb releases may be made from TER with the switch in either ROCKET NORMAL or CBU position as the fire pulses are delivered directly to the ejector units. In the AUTO RIPPLE position, all bombs will release in a fast ripple with a continuous fire pulse applied to the TER. The AUTO RIPPLE position is not compatible with the tactical computer.

The TER will automatically step through an unloaded rack station. Transfer to the next higher priority wing station will occur with release of the Release Enable switch, depending upon store type, quantity selected, stations selected, and whether or not the MER/TER intervalometer has made a complete cycle.

A/A37B-6 Multiple Ejector Rack (MER)

The multiple ejector rack can be used on all wing pylons. The rack attaches to the BRU 10/A ejector rack. As many as six bombs can be carried on each MER. Rack stations are arranged in forward and aft groups of three. Firing or releasing modes depend on the prepositioning of MER and store mounted controls. The MER is safetied in the same manner as the TER.

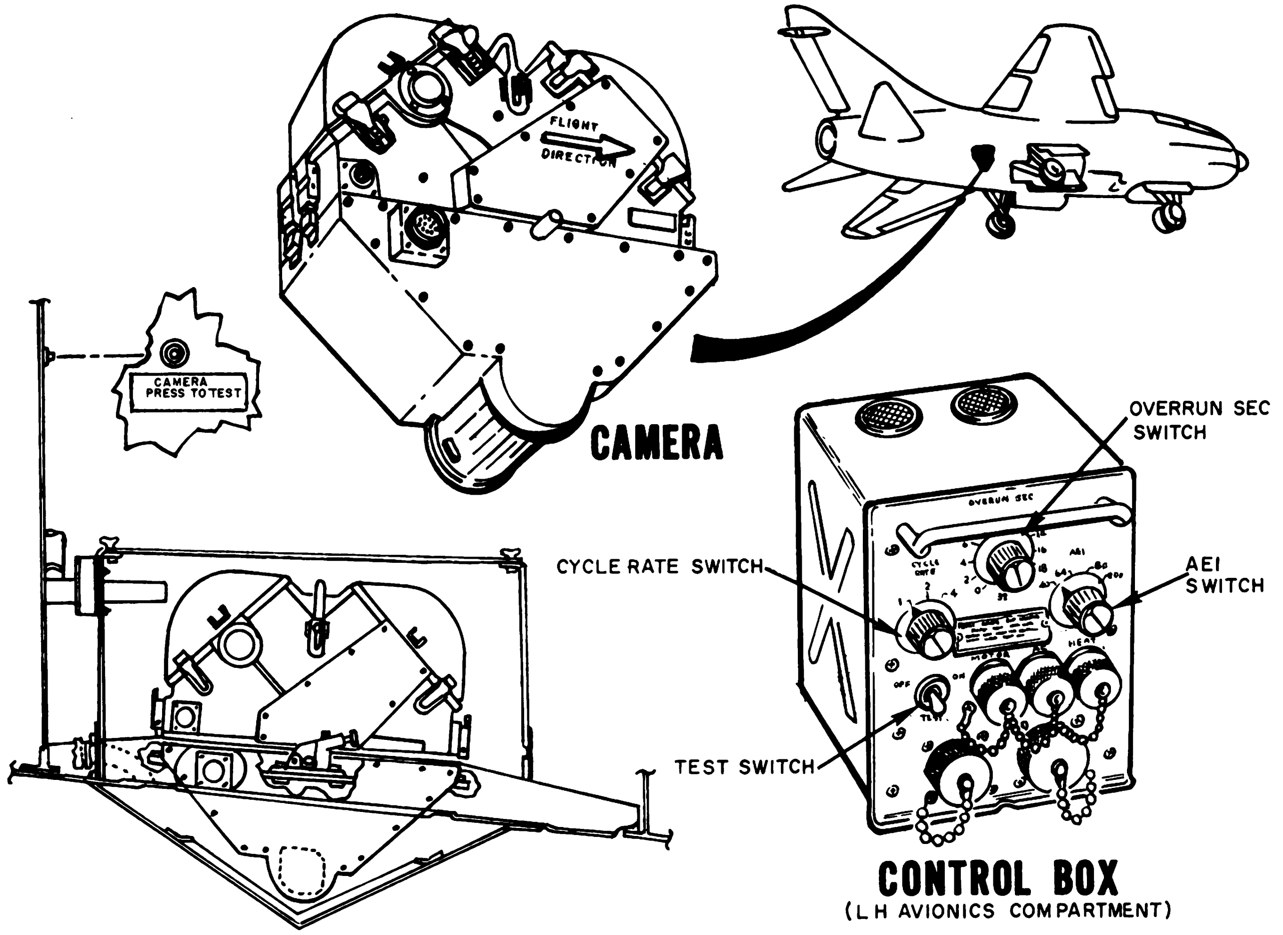
Rockets are not carried on the MER in the A-7E. Either the Rockets Normal or CBU switch position may be used for normal bomb release from MER as the fire pulses are delivered to the ejector units, provided the ASCU is not set for dispenser or rocket type store settings. Each fire pulse to the MER releases one bomb in the order of aft center, forward center, aft left, forward left, aft right, and forward right. MER will automatically step through an empty rack station. Automatic stepping is accomplished in the same manner as the TER. In the AUTO RIPPLE position, bomb release would be accomplished in the same manner as the TER; however, the AUTO RIPPLE position is not compatible with the tactical computer. Release order is aft center, forward center, aft left, forward left, aft right, and forward right.

KB-18A STRIKE CAMERA

The Strike Camera KB-18A (fig. 4-3) is loaded and maintained by the AO's within an A-7E squadron. The camera is used to provide a photographic record of weapon delivery effectiveness, and thus serves as an aid in assessing the damage which results from a strike on a target. In addition to its use for strike assessment, it can also be used for aerial reconnaissance.

The camera can be used on any daylight mission and used at night with the aid of an illumination flare. It is located in the engine bay compartment and aft of the right main landing gear. The camera is housed in a sealed unit (all of which is inside the engine bay compartment) that is temperature controlled to maintain the range between 70° and 90° F. The engine bay compartment has a window in the bottom that permits the camera to take pictures.

The camera can be loaded with enough film to provide 300 pictures of 70-mm panoramic photographic coverage 180° along and 20° to each side of the flight path.



AO.504

Figure 4-3.—KB-18A strike camera installation.

The camera control box is located in the left avionics bay of the A-7E. Three switches require setting prior to a mission. The CYCLE RATE SWITCH allows the selection of an exposure rate of 1, 2, or 4 frames per second. The OVERRUN SEC switch controls the length of time for extended camera operation after the trigger is released (from 0 to 32 seconds). The AEI (automatic exposure index) switch provides manual setting of the diaphragm opening for film sensitivity from 40 to 200.

WEAPON DELIVERY

Tactical air warfare requires the delivery aircraft to fly close to the target in order to effectively deliver bombs, gunfire, and various other weapons. Guided missiles can be fired while still miles away from the target. Regardless of what types of weapons are being carried, it is essential that the A-7E deliver these weapons to a place where they can be fired or released onto a target.

The weapon delivery system is a subsystem of the weapon management system. It is important to realize that the weapon delivery system does not fire or release weapons; nor does it control (arm, prepare for use, etc.) the weapons. The weapon delivery system is used by the pilot to aid him in reaching (flying to) a point in space where the weapons may be fired, launched, or eleased onto a target. The system also tells he pilot when he has reached the release point where the weapon control system and weapon elease system take over and initiate control nd release signals to the weapon stations). The veapon delivery system is maintained by the O and AQ rates. The principal components of he weapon delivery system are discussed in the ollowing paragraphs.

Veapons Delivery Subsystems

There are eight principal subsystems that nake up the weapon delivery system. The subystems and their functions are as follows:

1. Forward-looking radar—provides air-to-round ranging and ground mapping.
2. Tactical computer—performs navigation nd weapon delivery computation.
3. Head-up display set—an optical/electronic et that provides the pilot with flight and weapon lelivery information.
4. Armament station control unit—tells the omputer the types of weapons that are to be eleased or fired, performs logic and control perations concerning the use of weapons.
5. Inertial measurement set—measures airraft pitch, roll, and yaw attitudes; measures all hree components (vertical, longitudinal, and ateral) of aircraft velocity.
6. Air data computer—computes the airraft's airspeed and altitude.
7. Doppler navigation radar—determines roundspeed and drift angle.
8. Radar beacon set—enables ground stations o determine range and location of the aircraft.

These eight subsystems are essentially avioics equipment and are covered in the A-7E vionics instructions manuals, rather than in his manual. However, the AO must be familiar vith three of these subsystems—the head-up lisplay (HUD) set, the tactical computer, and the rmament station control unit (ASCU).

HEAD-UP DISPLAY.—The head-up display HUD) (fig. 4-4) is an optical and electronic levice that projects navigation and weapon lelivery information onto a combiner glass. The combiner glass is mounted above the nstrument panel and in the center.) The infornation reflected on the combiner glass enables he pilot to fly the aircraft with his head up, ather than requiring him to look down at nstruments and displays on the instrument anel.

Symbols (such as lines and circles) are projected onto the combiner glass, telling the pilot which direction to fly the aircraft, when to fire or release the weapons, and other information regarding navigation and weapon delivery.

There are six modes of weapon delivery—one manual and five computed modes. When using the HUD in any of the five computed modes, the projected symbology on the combiner glass tells the pilot how he should steer the aircraft in order to carry out an accurate weapon delivery. The various subsystems of the weapon delivery system (inertial measurement set, forward-looking radar, etc.) supply data (such as aircraft altitude, airspeed, angle of attack, and drift angle) to the HUD's signal data processor (located in the left-hand avionics bay) which in turn sends display information to the HUD's unit in the cockpit.

When the HUD is used in the noncomputed (manual) delivery mode, its symbology consists only of a fixed aiming reticle.

The HUD is normally a responsibility of the AQ or the Weapons Verification Crew; but should be understood by the AO since it is a component closely associated with his equipment.

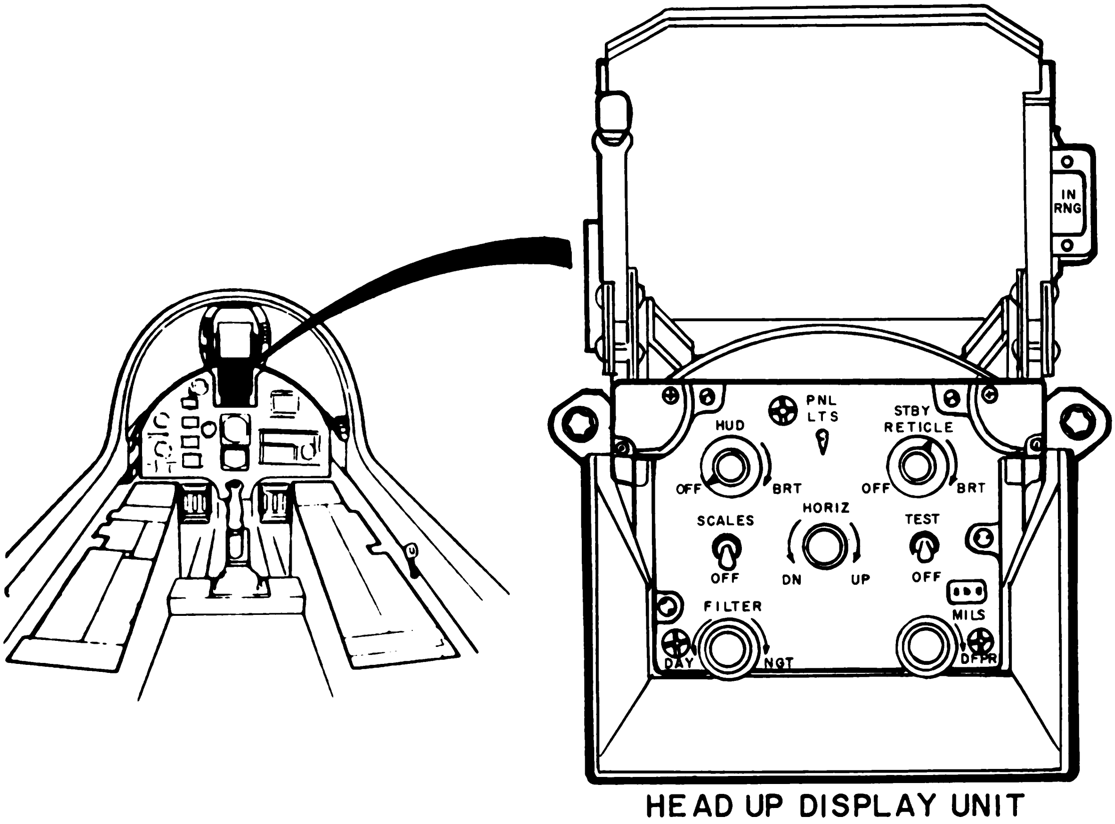
TACTICAL COMPUTER.—The A-7E is equipped with the AN/ASN-91 tactical computer which is a general-purpose digital computer. This computer helps the pilot accomplish accurate delivery of weapons and solving complex navigation problems.

The ASN-91 control panel provides for entry and display (on the HUD) of data required for navigation and navigational updating. These data include such information as latitude, longitude, target elevation, wind, burst height, and range-to-target.

The AN/ASN-91 is used in all five (radar bomb, navigation bomb, normal attach, normal offset, and radar offset) computed modes. The particular computed delivery mode desired by the pilot is selected by depressing the desired MASTER FUNCTION switch located on the left side of the instrument panel.

Once the computer determines that the aircraft has arrived at the release point, it will generate one or more firing pulses, provided the pilot has depressed the weapon release switch which is located on the stick grip. These pulses will then be routed to the ASCU for proper distribution to the selected station(s).

The pilot can select a manual attack by insuring that none of the five master function switches are depressed. Manual attack mode



AO.505

Figure 4-4.—Head-up display.

is also used by the AO's in performing ground system checks.

ARMAMENT STATION CONTROL UNIT (ASCU).—The ASCU is the heart of the weapons management system, and is located in the left avionic bay and provides the necessary control and release functions for weapons and external stores with the exception of fuel tanks and nuclear weapons. Jettison capability only is provided for fuel tanks. Nuclear weapons control is connected directly to stations 2 and 7 pylons.

A built-in priority system is contained within the control logic section of the ASCU. The control logic, in conjunction with the single-pairs-simult rkts switch on the armament release panel, determines the exact sequence of release from selected stations. The transfer point from an empty station to the next higher priority station is also determined in the control logic section.

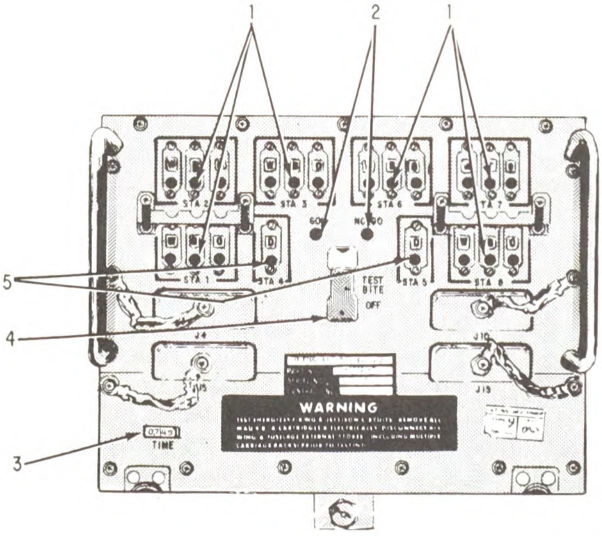
Fuselage stations 4 and 5, when selected, always have priority over wing stations and are independent of the single-pairs-simult rkts switch. With SINGLE selected, one weapon is released from a selected wing station with each release pulse. Wing station priority is 1, 8, 2, 7, 3, 6. With PAIRS selected, two weapons are released at a time, one each from a symmetrical pair of wing stations, with each release pulse. Station priority is 1 and 8, 2 and 7, 3 and 6. With SIMULT RKTS selected, one release pulse to all selected wing stations provides simultaneous release of rockets only from those stations.

The ASCU panel is illustrated in figure 4-5. The numbers shown on the figure refer to nomenclature numbers shown in table 4-2. The panel provides three store type pushbutton switches for each wing station and one store type pushbutton switch for each fuselage station. Each switch provides positions which are marked with letters corresponding to the code assigned to each individual store. One switch for each wing station has a range of A through J; another, K through T; and the other, V through Z. The fuselage station settings are A, B, C, D, and E recurring. Before flight each station store type switch is set with the code that identifies the store carried on that station. When a station is selected and is top in priority, the weapon type for that station is transmitted to the tactical computer. The ASCU supplies the electrical outputs necessary to arm and release or jettison the specific external store present and selected. In addition, the ASCU completes circuitry for armament advisory light indications when stations (stores) are selected.

Store type letter code, computed solution availability, and ballistic envelope requirements may be found in NavAir 01-45AAE-1T. The first digit corresponds to fuzing as follows:

W - no fuzing required.
X - mechanical fuzing.
Y - electrical fuzing.
Z - either electrical or mechanical fuzing.

The other digits identify weapon type and enable the tactical computer to determine ballistics, retardation delay time, ejection velocity, and the range of weapon effects.



AO.506

Figure 4-5.–Armament station control unit.

The ASCU contains built-in-test-equipment (BITE) for use by ground personnel in detecting faults within the ASCU. BITE is initiated by placing the BITE switch in TEST. After approximately 20 seconds, while the ASCU cycles through the release sequence for all weapon types, either a GO or a NO GO light on the front of the ASCU indicates the ASCU is functioning properly or a malfunction exists.

NOTE: Before operating BITE, all stores and racks must be electrically disconnected since the weapon release circuits are energized during the BITE test.

WEAPON CONTROL SYSTEM

Different missions usually require different weapons. One mission may be entirely a bombing strike, while another will delivery rockets or a chemical spray. The type of mission being flown will determine the types of weapons that will be carried on the aircraft. Thus, the pilot must be able to select and use his weapons as mission deeds dictate. The weapon control system in the A-7E does the following three things:

1. Selects and enables weapons.
2. Arms the selected weapons that require arming.
3. Advises the pilot of the status of his weapons.

Armament Control Selectors

The armament selectors (fig. 4-6) are a series of internally illuminated pushbutton selectors located below the instrument cowl. Armament stations or control functions are selected by pressing the appropriate selector. A mechanical hold-in maintains contact and holds the selector depressed until it is pressed a second time. The POD CLEAR selector is not used. Internal illumination is either green, yellow, or red, depending on the logic and the selector. All selectors are internally illuminated red when deselected and the red instrument panel lighting is on. Under daylight, the selector legends appear white.

Station Selectors

The station selectors are numbered 1 through 8 and are located below the left instrument cowl. Stations are selected by pressing the appropriate

Table 4-2.–Armament station control unit nomenclature and function.

Nomenclature	Function
1. Wing station store type switches.	SET–three pushbutton switches set for the code which identifies the store loaded on the corresponding wing station.
2. GO - NO GO lights.	GO–indicates the ASCU is functioning properly when the BITE switch is held in the TEST position (MASTER ARM selected). NO GO–indicates the ASCU is functioning properly when the BITE switch is held in the TEST position (MASTER ARM deselected) or the ASCU has a malfunction (MASTER ARM selected).
3. Time totalizing meter.	Records a running total of all unit "ON" time, including standby time.
4. BITE switch.	TEST–used in conjunction with the GO - NO GO lights to test the ASCU circuits. The switch must be held in the TEST position and will return to OFF when released.
5. Fuselage station store type switches.	SET–one pushbutton switch for each fuselage station selects the letter code for the store carried on each fuselage station.

(1 through 8) selector. Stations are deselected by pressing a second time.

One selector is provided for each station, which allows the pilot to select and ready each station or combination of stations desired. Each selector also completes the circuit to the armament advistory lights on the instrument panel indicating the type of store preset on the ASCU for the selected station. Each station selector illuminates green when the logic is complete and the station is ready for armed release of store (without regard to MASTER ARM or station priority).

Nose Fuze Selector

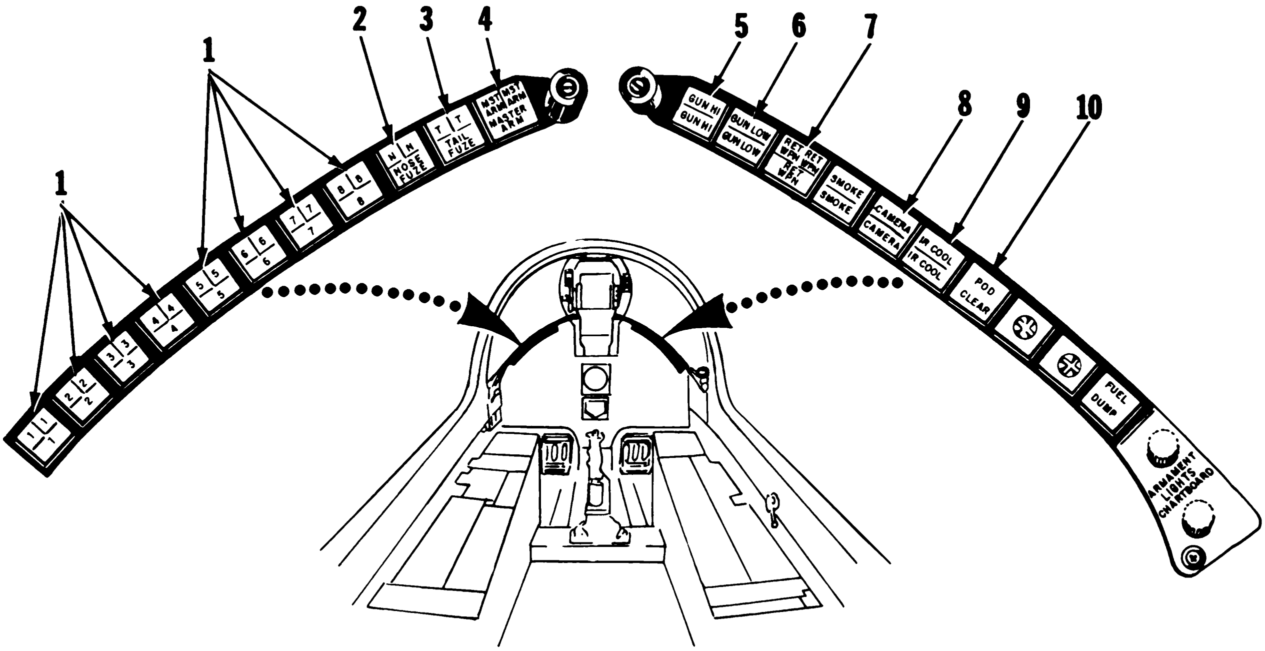
The nose fuze selector allows power to be supplied to the nose mechanical arming solenoids of MER/TER and BRU 10/A racks on selected stations provided MASTER ARM is selected. N illuminates yellow if no station requiring mechanical fuzing is selected. NOSE FUZE illuminates green if a station requiring mechanical fuzing is properly selected and loaded.

Tail Fuze Selector

The tail fuse selector allows power to be supplied to the tail mechanical arming solenoids of MER/TER and BRU 10/A racks on selected stations provided MASTER ARM is selected. This selector is disabled for those stations with ASCU store type switches set to one of the in-flight option Snakeye positions. T illuminates yellow if no station requiring mechanical fuzing is selected. TAIL FUZE illuminates green if a station requiring mechanical fuzing is properly selected and loaded (Snakeye HD/LD excepted).

Master Arm Selector

The MASTER ARM selector provides secondary d-c bus power to the armament system when the landing gear handle is up or after the armament-safety-disable switch is activated with the aircraft on the deck. MASTER ARM selector illuminates green when selected, also if a selected station is ready for armed release or if the GUN HI or GUN LOW selector is selected. MASTER ARM selector illuminates



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1. Station selectors.
2. NOSE FUZE.
3. TAIL FUZE.
4. MASTER ARM.
5. GUN HI.
6. GUN LOW.
7. RET. WPN.
8. CAMERA.
9. IR COOL.
10. POD CLEAR

Figure 4-6.–Armament selectors.

yellow when selected and no station is ready for armed release (logic is incomplete).

GUN HI and GUN LOW Selectors

The GUN HI and GUN LOW selectors complete the circuits for internal gun (M61A1) firing when the MASTER ARM selector is selected and the trigger is squeezed to the second detent. If both selectors are pressed, only GUN LOW will be illuminated and the gun will fire at the low rate. Selectors illuminate green when selected. GUN HI provides a high rate of fire (6,000 rounds per minute) and GUN LOW provides a low rate of fire (4,000 rounds per minute) for the gun.

Retarded Weapon Selector

The retarded weapon selector (RET WPN) supplies power to the tail mechanical arming solenoids of MER/TER and BRU 10/A on selected stations that have ASCU switches set in one of the in-flight option Snakeye positions and a store is present. This selector allows the pilot to select the high-drag fin configuration. If a selected station is set for an in-flight option or a high-drag store, RET WPN will illuminate yellow if the ASCU is not set for an in-flight option or high-drag store, when no stations are selected, or no store is present. The selector will immediately illuminate green (whether pressed or not) when a station is selected whose ASCU store type switch is preset for a high-drag store.

Camera Selector

The camera selector provides power to the KB-18A strike camera which operates automatically during gunfiring or store release. Camera overrun is preset prior to takeoff.

CAMERA illuminates green when selected. To manually operate the strike camera without releasing weapons, press the Camera selector, deselect MASTER ARM, and squeeze the trigger. Camera overrun is not provided during manual operation.

IR Cool Selector

The IR cool selector allows nitrogen coolant to flow from the LAU-7/A launcher to the AIM-9D Sidewinder missile. The selector should be pressed at least 5 minutes before launching the missile. IR COOL illuminates green when pressed and is independent of MASTER ARM or station selector positions. Coolant flow to missiles is stopped when IR cool is deselected.

Armament Advisory Lights

The armament advisory lights are a series of indicator lights located on the instrument panel that provide the pilot with armament system information. The lights provide indication of ASCU store type switch setting for selected stations and whether or not mechanical of electrical fuzing is required. See figure 4-7 and table 4-3 for functioning of the armament advisory lights.

Master Function Selectors

The master function selectors are a series of pushbuttons located on left side of the instrument panel that provide the pilot with a selection of data link controlled or tactical computer controlled attack modes and navigation or landing modes. Computed modes are normal attack, radar bomb, and navigation bomb. If none of these attack modes are selected, delivery can be made in a manual mode. Modes are selected by pressing the appropriate pushbutton, causing the light to illuminate yellow. Modes are deselected by pressing the same pushbutton again or by selecting another mode. Offset may be used with normal attack and radar bomb. The master function selectors are shown in figure 4-8; the nomenclature and the function of each pushbutton are contained in table 4-4.

Armament Release Panel

The armament release panel (fig. 4-9 and table 4-5) consists of three switches. One allows the pilot to preselect the number of stores to be released; another allows the pilot to select the interval of release; and the other allows the pilot to choose whether the stores will release singly or in pairs or will simultaneously release rockets from all selected rocket-loaded stations.

SINGLE-PAIRS-SIMULT RKTS SWITCH.—The single-pairs-simult rkts switch is a three-position toggle switch located on the armament release panel. The SINGLE position delivers a fire pulse to one station at a time, starting with the highest priority wing station selected. Wing station priority is 1, 8, 2, 7, 3, 6; fuselage stations 4 and 5 are independent of the single-pairs-simult rkts switch. The PAIRS position releases two stores simultaneously (one from each wing) from the most outboard (highest priority) left and right symmetrical wing stations selected. Station transfer is automatic. Priority is 1 and 8, 2 and 7, 3 and 6. (Fuselage stations have higher priority than wing stations and will fire before wing stations if the fuselage stations are also selected.) With the switch in the SIMULT RKTS position, each fire pulse is delivered simultaneously to each selected wing station loaded with rocket launchers. If selected wing stations are loaded with stores other than rockets, they will not be released and cannot be readied.

QUANTITY SWITCH.—The quantity switch allows the pilot to select the quantity of fire pulses to be initiated by the tactical computer when in computed mode of attack or in manual mode of attack with a quantity of 2 or more selected. When in the manual mode of attack with a quantity of 00 to 01 selected, a single fire pulse will be delivered each time the release enable switch is pressed. The quantity switch is not applicable to internal gun, Walleye, Sidewinder, rockets, smoke tanks, or spray tanks.

INTERVAL-FT SWITCH.—This switch allows the pilot to select the interval, in 10-foot increments, between store impact points on the ground for computed deliveries or the distance flown along the ground track between releases for manual releases, with a quantity of 2 or more selected.

Control Stick

The control stick contains the designate switch, release enable switch, and the trigger. The release enable switch is used to actuate or fire fuselage stores and release or fire all wing

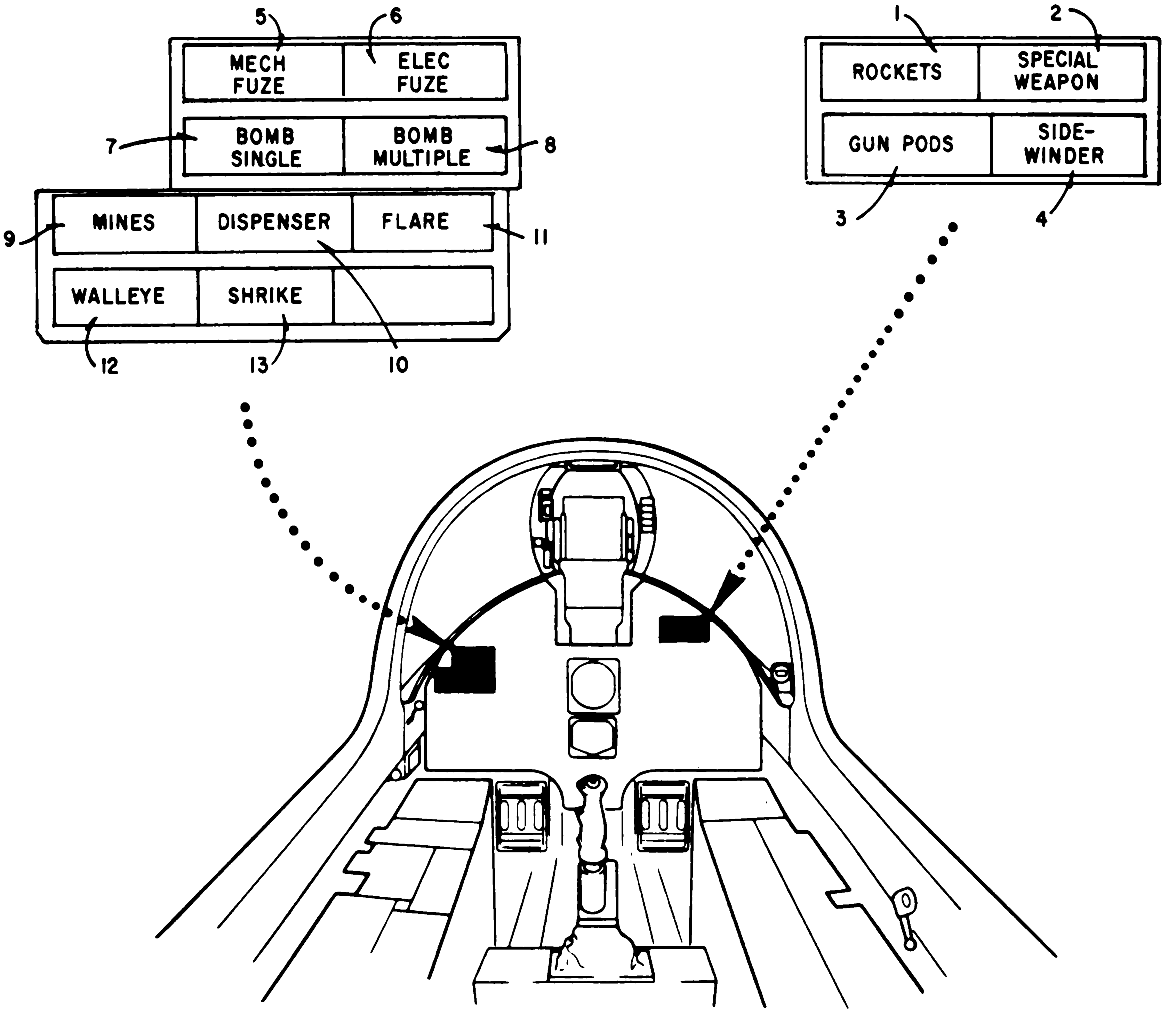

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Figure 4-7.—Armament advisory lights.

stores. When in a computed attack mode, pressing the release enable switch will designate the target if not done previously with the designate switch. The trigger fires the internal gun and is used for manual and automatic operation of the strike camera.

WEAPON RELEASE SYSTEM

Once the weapon control system has everything ready for release or firing, and the pilot with the aid of the weapon delivery system maneuvers the aircraft to a valid release point, readied weapons are fired or released by the weapon release system. Generally speaking, there are two ways to fire and release weapons: (1) normal firing and release and (2) jettison.

Normal Firing and Release

There are two swtiches that the pilot uses to fire and release weapons. Both are located on the pilots stick grip; they are the trigger and armament release switches.

The trigger will fire the internal gun (M61A1) and external (wing mounted) gun pods. The

Table 4-3.—Nomenclature and function of the armament advisory lights.

Nomenclature	Function
1. ROCKETS light.	On (ROCKETS)—indicates a station has been selected and set for single or multiple rocket launchers. OFF—indicates one of the following has occurred: 1. All applicable stations are deselected. 2. A fire pulse has been delivered to each launcher selected in SINGLE or PAIRS sequence. 3. If in SIMULT RKTS sequence, all applicable stations have been deselected (with exception of fuselage stations which revert to SINGLE sequence).
2. SPECIAL WEAPONS light.	On (SPECIAL WEAPON)—indicates a station has been selected and set for one of the following nuclear weapons: B 43, B 57, or B 61. Off—indicates station selected has received a release pulse or has been deselected.
3. GUN PODS light.	Not used.
4. SIDEWINDER light.	On (SIDEWINDER)—indicates a station has been selected and set for AIM-9B or AIM-9D Sidewinder missile. Off—indicates a fire pulse has been delivered to all applicable stations and missile has left the launcher, or the applicable stations are deselected.
5. MECH FUZE light.	On (MECH FUZE)—indicates a selected station has been set for a store that requires mechanical fuzing only or for a store that has both mechanical and electrical fuzing and is loaded. Off—indicates all applicable stations have been deselected or are empty.
6. ELEC FUZE light.	On (ELEC FUZE)—indicates a selected station has been set for a store that requires electrical fuzing only, or for a store that has both electrical and mechanical fuzing and is loaded. Off—indicates all applicable stations have been deselected or are empty.

Table 4-3.–Nomenclature and function of the armament advisory lights–Continued.

Nomenclature	Function
7. BOMB SINGLE light.	On (BOMB SINGLE)–indicates a selected station has been set for a single mounted store. Off–indicates a release pulse has been delivered to all applicable stations or has been deselected.
8. BOMB MULTIPLE light.	On (BOMB MULTIPLE)–indicates a selected station has been set for stores carried on MER, TER, or PMBR. Off–indicates one of the following has occured: 1. MER/TER has completed one release cycle. 2. If PMBR is carried, stations are deselected. 3. All applicable stations are deselected.
9. MINES light.	On (MINES)–indicates a station has been selected and set for one of the following stores: Mk 36 mine, Mk 52 mine, Mk 55 mine, Mk 56 mine.
10. DISPENSER light.	On (DISPENSER)–indicates a station has been selected and set for one of the following stores: CBU-1A/A dispenser, CBU-2A/A dispenser, Mk 12 Mod O smoke tank, or Aero-10B spray tank. Off–indicates one of the following has occured: 1. Empty signal received from single-mounted CBU dispenser on all applicable stations. 2. One fire pulse received to each smoke tank on all applicable stations. 3. For Aero-14B spray tanks, only when station is deselected. 4. All applicable stations have been deselected.
11. FLARE light.	On (FLARE)–indicates a selected station has been set for SUU-40/A, 44/A flare launcher (single or multiple loaded) or for Mk 24, Mk 45 flares on MER or PMBR. Off–MER has completed one release cycle (Mk 24, Mk 45 flares on MER only). All other applicable stations must be deselected.
12. WALLEYE light.	On (WALLEYE)–indicates a station has been selected and set for Mk 1 Mod 0 Walleye. Off–indicates a release pulse has been delivered to all applicable stations or has been deselected.

Table 4-3.—Nomenclature and function of the armament advisory lights—Continued.

Nomenclature	Function
13. SHRIKE light.	On (SHRIKE)—indicates a selected station has been set for AGM-45A Shrike Guided missile. Off—indicates a release pulse has been delivered to all applicable stations or has been deselected.

trigger is actually two electrical switches—one closes when the trigger is squeezed to the first detent (operates the camera system if selected), and the second detent fires the M61A1 20-mm internal gun and external mounted gun pods.

The armament release switch (located near the top and on the left side of the stick grip) will fire or release all stores on the plane except the internal gun and external mounted gun pods.

Jettison Capability

Jettison is the discarding of stores from an airborne aircraft. There are two general reasons for jettisoning stores—an emergency (as when jumped by enemy aircraft) and for matters of convenience (such as discarding empty rocket pods after the rockets have been fired).

The pilot can jettison all or part of the external stores from all wing stations (stations 1, 2, 3, 6, 7, and 8). A store can be jettisoned by ejecting the weapon from its ejector rack (just as in a normal release) or by ejecting the secondary rack (such as a MER or TER) that carries the weapon(s). Guided missiles may be jettisoned (except Shrike) by launching unarmed and unguided.

The only way to jettison Sidewinders from the fuselage stations (stations 4 and 5) is to

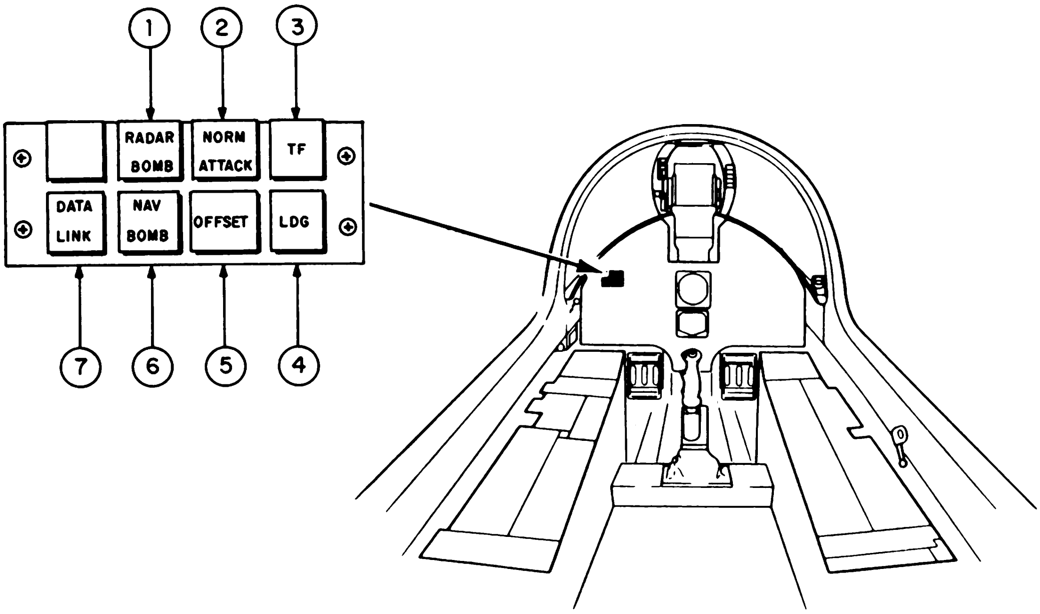

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Figure 4-8.—Master function selectors.

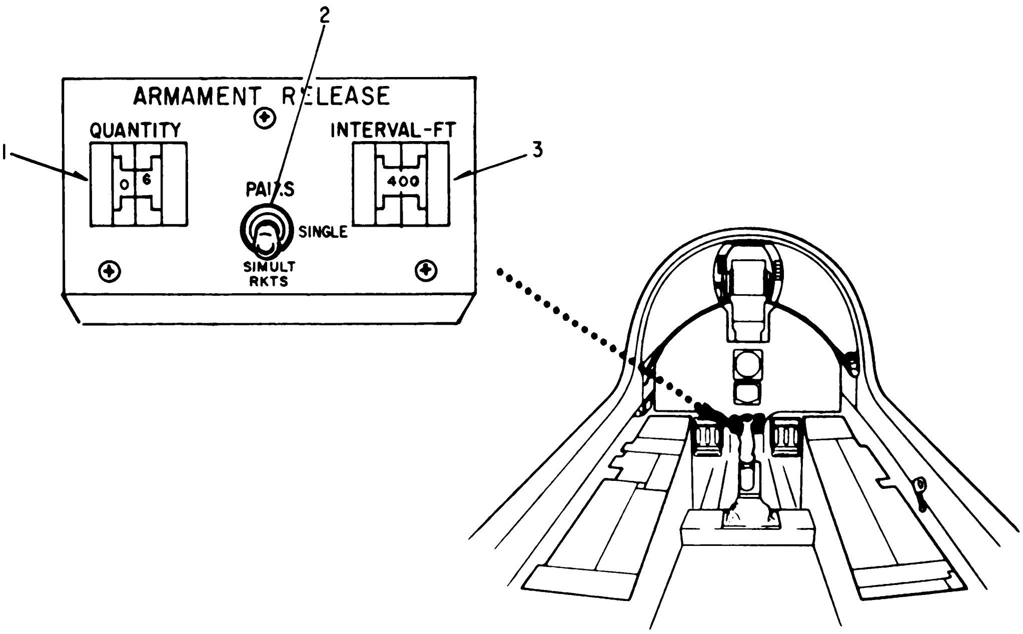

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Figure 4-9.–Armament release panel.

launch them unarmed and unguided. The Sidewinder cannot be ejected from the fuselage stations due to it striking the inboard wing pylon; thus it must be fired to be jettisoned.

Wing pylons cannot be ejected because they are bolted to the aircraft structure.

SALVO JETTISON.–When the salvo jettison switch (pushbutton switch located on the left center of the instrument panel) is depressed, everything that can be "cleared" from the six wing stations will be jettisoned. This switch cannot be used to clear the two fuselage stations. The master arm switch does not have to be on, nor must the wing stations be selected. However, the aircraft must be airbone with the landing gear up and locked.

SELECT JETTISON.–The select jettison feature is like the salvo jettison operation, except that in select jettison the stations must be selected before a wing station can be cleared. The select jettison feature is the only way stores can be jettisoned from the two fuselage stations. Like the salvo jettison, the select jettison does not arm the stores.

AUXILIARY JETTISON.–The third jettison method – auxiliary jettison–permits jettison of armed weapons. Auxiliary jettison is used when it is desired to discard only weapons, pods, or tanks from selected wing stations. This permits jettisoning of stores from secondary racks (MER or TER) without releasing them from the primary racks (BRU 10/A). The pilot also has the choice of mechanically arming the weapon prior to release.

When using auxiliary jettison, the landing gear must be up and locked, master arm power on, and the station(s) to be jettisoned must be selected.

NUCLEAR WEAPON CONTROLS

The Aircraft Monitor and Control (AMAC) Panel DCK-143 is installed so that the pilot may simultaneously monitor and control the safe or armed status of two nuclear weapons when loaded on stations 2 and 7. The DCK-143 is installed on the left console in place of the AN/AWW-2B fuze function control panel (fig. 4-10).

Mode selections available to the pilot are arming, delay time, air or ground burst, and free fall or retarded delivery. An emergency

Table 4-4.—Master function selectors.

Nomenclature	Function
1. RADAR BOMB.	SELECTED—selects the radar bomb mode of attack for the weapons delivery system.
2. NORM ATTACK.	SELECTED—selects the normal attack mode for the weapons delivery system. Used for computed lead for rockets and internal gun.
3. TF.	SELECTED—selects terrain following mode. Causes HUD and ADI to display TF and Navigation mode symbology.
4. LDG.	SELECTED--selects the All Weather Carrier Landing System (AWCLS) mode. Causes the HUD to display landing symbology. The HSI displays TACAN distance and bearing and the ADI shows correction to fly to the desired glide path. Flightpath data is commanded by Data Link.
5. OFFSET.	SELECTED—used in conjunction with the normal attack or radar bomb mode to attack a target that may not be visible but can be located in relation to an Offset Aimpoint (OAP).
6. NAV BOMB.	SELECTED—selects the navigation bomb mode, uses target coordinates as stored in the tactical computer, as a normal destination.
7. DATA LINK.	SELECTED—decouples the tactical computer and couples data link guidance.

NOTE: When all Master Function selectors are deselected, the weapon delivery system is in the Manual mode.

safing circuit is provided to safe the weapon(s) in the event that the normal system safing circuits malfunction.

TEST EQUIPMENT

Table 4-6 shows some of the various types of test equipment and their purpose as applied to the A-7E aircraft. The Weapons Verification Crew normally performs all testing on the systems and works with the armament branch AO's in correcting any discrepancy located.

ELECTRICAL FUZING SYSTEMS

Electrical fuzing systems are used to allow the pilot a choice of arming and firing delays while airborne. The Fuze Function Control (FFC) Set AN/AWW-1 was the first system used in the fleet and is still used in some aircraft. The AN/AWW-2A was next; but due to some of the shortcomings in the system (in regard to multiple loads), the AN/AWW-2B was designed as an addition to the -2A for some weapons load combination. The latest design in FFC systems is the AN/AWW-4.

The AN/AWW-2A and AN/AWW-2B are used on A-7 aircraft. The AN/AWW-4 is to be used in the F-4J and as a replacement for the AN/AWW-2A in the A-7E aircraft, but it can also be used in any aircraft with the AN/AWW-1 capability.

Electric bomb fuzes are discussed in AO 3 & 2, NavPers 10345-C and NavAir 11-5A-17 and should be reviewed along with this section.

Table 4-5.–Armament release panel switch functions.

Nomenclature	Function
1. Quantity thumbwheel.	00-99–selects the quantity of fire pulses to be delivered in a computed mode or in manual mode with a quantity of 2 or more. If set at 01, one fire pulse is delivered each time the release enable switch is pressed in manual mode when set at 00 or 01.
2. Single-pairs-simult rkts switch.	SINGLE–single mounted stores are released from one wing station at a time with each fire pulse. Station priority is 5, 4, 1, 8, 2, 7, 3, 6 if all stations are selected. Fuselage stations are independent of switch, but are in priority if selected. PAIRS–two stores (one from each wing) are released simultaneously from the most outboard LH and RH symmetrical wing stations selected, with each fire pulse delivered. Sequence will revert to SINGLE under the following conditions: 1. Only one station selected. 2. Stations selected are not symmetrical. 3. Symmetrical stations selected but one is empty. 4. One or both selected stations loaded with a Walleye or Sidewinder. 5. Fuselage station selected. SIMULT RKTS–each fire pulse delivered simultaneously to selected wing station loaded with rocket launchers.
3. Interval-Ft thumbwheel.	010-990–selects the interval, in 10-foot increments, between impact points on the ground for computed deliveries, or the distance flown along the flightpath between releases for manual deliveries with a quantity of two or more selected.

FUZE FUNCTION CONTROL SETS AN/AWW-2A/B

The AN/AWW-2A and AN/AWW-2B electrical fuzing systems provide regulated d-c voltages required for arming d-c and RF electrical fuzes. The system also provides RF signals for selected arming and detonation time delays in RF electrical fuzes. The different components and their functions for the AN/AWW-2A and AN/AWW-2B electrical fuzing systems are listed in table 4-7.

The control box contains all the controls and circuits necessary to provide selection of arming and firing delay voltage options and the specific type of electric fuze to be charged. (See fig. 4-11 and table 4-8). These controls include an arming delay switch, a firing delay switch, a function switch, an interlock override switch, and a high voltage d-c test switch. A momentary test switch and light on the control box indicate that the

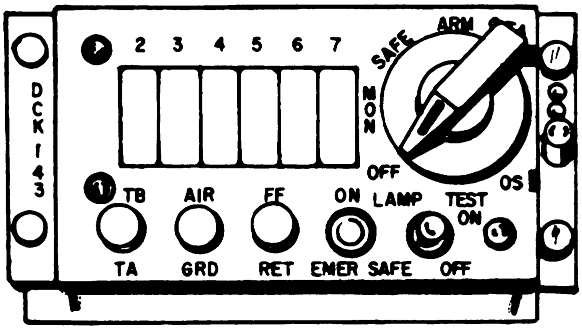

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Figure 4-10.—DCK-143 AMAC panel.

fuzing system is ready for operation. The amplifier-power supply provides accurate crystal-controlled RF and regulated d-c voltages for the system.

The AN/AWW-2A arming delay switch selects one of four arming delay options built into the weapon fuze of 2.0, 4.5, 8.0, and 20.0 seconds. The minimum elapsed time between launch and firing of the weapon is therefore 2 seconds. The AN/AWW-2B arming delay switch selects one of four arming delay options of 5.5, 8, 10, and 20 seconds. However, the system interlock circuit will convert the lowest delay time to the next step (4.5 seconds for the -2A and 8 seconds for the -2B) unless the interlock circuit is intentionally overridden by the interlock override switch.

The firing delay switch selects one of six firing delay options (0.0004, 0.101, 0.025, 0.50, 5.0, or 20.0 seconds after impact), or an instant option which fires the weapon upon impact. The function switch selects one of four d-c voltages (+300, +195, -195, or -300 volts) for charging d-c type fuzes, or selects one of two options (VT proximity or IMP impact) for RF type weapon fuzes. The EXT position has no function assigned, and in the safe position the weapon fuzes cannot be charged.

Operation

The electrical fuzing system is energized when the function selector d-c power is in any position other than EXT or SAFE. Rotating the function switch to any position other than EXT or SAFE places the system in a ready condition. With the system in a ready condition and the desired wing station select switch selected, pressing the bomb release switch applies power to the output relay in the amplifier-power supply. The energized relay connects 28 volts d.c. to the oscillator amplifiers which in turn apply the fuzing signal to the bomb arming unit of the selected wing station.

The test switch and light verify that the electrical fuzing system is ready to operate. Actuating the press-to-test switch connects the return side of the high-voltage transformer primary to ground, bypassing the open interlock contacts of the landing gear up-and-locked No. 2 relay (landing gear extended). Power is normally connected to the high-voltage transformer when the function selector switch is placed in a position other than SAFE. High-voltage d-c power is supplied from the bridge rectifier to cause the high-voltage d-c test indicator light to come on, indicating that the electrical fuzing system is ready to operate.

The amplifier-power supply generates the required d-c power and RF signal frequencies from the aircraft primary power sources. The AM-4708/AWW-2A receives +28 volts d.c. when used with the Fuzing System AN/AWW-2A and the AM-4708A/AWW-2A used with the AN/AWW-2B system requires an aircraft input of 115-volt, 400-hertz, 3-phase power. The RF type electric weapon fuzes are charged by +300 volts d.c. This voltage is present in the signal output to the fuzes when any one of three RF fuze type options is selected by the function switch on the fuze function control. The RF signal frequencies, which control the arming and firing delay options, are generated by eight crystal-controlled oscillator modules in the amplifier-power supply. The selected RF signal frequency or combination of frequencies is superimposed on + 300 volts d.c., and the resultant signal output is applied simultaneously to the RF weapon fuzes. Tuned circuits in the fuzes sense the presence of their resonant frequencies and actuate RF squibs. The actuated RF squibs apply fixed values of resistance to RC timing circuits in the fuzes and establish the time constants for the arming and firing options selected. Energy for charging the fuzes is provided by the +300-volt d-c component of the signal.

The d-c type weapon fuzes contain capacitors that are charged by d-c voltages if the d-c option is selected. These capacitors discharge to supply the energey to charge the fuzes after the weapons have left the aircraft. The specific fuze types and firing delays desired are the determining factors for the d-c voltage option selected.

Detailed information on the AN/AWW-2A FFC is contained in NavAir 11-5-118.

Table 4-6.—Test equipment.

Tester	Purpose
Weapon Release System Test Set AN/AWM-34A	Checks normal bomb/rocket/CBU release circuits, and nose/tail mechanical arming circuits. The test set has three modes of operation. The system mode checks the aircraft system and racks. The aircraft mode checks the aircraft systems only, and the rack mode checks MER/TER rack operation only.
Breech Cap Tester Mk 19	A GO-NO GO tester which tests for firing voltage at the auxiliary release breech cap. When firing, voltage is present at the breech cap, the circuit breaker trips, and a light comes on.
Armament Stray Voltage Tester AN/ASN 356	A GO-NO GO tester designed to provide information as to the presence or/absence of stray voltage at the breech caps of ejector racks.
Gun Control System Electrical Circuit Test Set AN/AWM-45	Designed to check the electrical gun controls and associated circuitry for the gun system.
Malfunction Isolation System Tester AN/AWM-48	Designed to be installed in place of the ASCU and by performing the checks as outlined in NA 01-45AAE-2-14. The tester will provide information as to the probable cause of a malfunction. This tester and checklist will tell you which component and connection to check to correct a malfunction.

Test Equipment

Two test sets (AN/AWM-4 and AN/AWM-31) are available for testing the AN/AWW-2A system. The test sets are used to perform the following tests and/or checks;

1. Preflight checks.
2. Adjustments.
3. Line maintenance.
4. Troubleshooting.
5. Operating d-c and RF channel checks.

Test Set AN/AWM-4 (fig. 4-12) was designed for testing of the Fuze Function Control Set AN/AWW-1 and other similar equipment that preceded the AN/AWW-2A system. The AN/AWM-4 is used to the extent of its applicability to the test and maintenance instructions contained in NavAir 11-5-118. Instructions for the proper use and operation of the Test Set AN/AWM-4 is contained in NavAir 16-30AWM4-1.

Test set AN/AWM-31 (fig. 4-13) is an improved version of the AN/AWM-4. It was especially designed to more accurately measure the outputs of all fuze function control sets, including the AN/AWW-1/2A/2B. Instructions for proper operation and use of the Test Set AN/AWM-31 are available in NAFI TP-333, Handbook Operation and Service Instructions for Test Set AN/AWM-31. Step-by-step procedures for performing a system check on the A-7E AN/AWW-2A/B electrical fuzing systems are contained in NavAir 01-45AAE-2-15.

Test Bench Harness AN/AWM-11A (fig. 4-14) incorporates component interconnections with connections to the test set for performing maintenance on the test set in a shop. NAFI TP-309 contains the operating instructions for this equipment.

AN/AWW-4 FUZE FUNCTION CONTROL SET

The Fuze Function Control Set AN/AWW-4 is an avionic equipment which provides high-voltage d-c electrical energy for the charging and arming of electric bomb and missile fuzes and the electrical initiation of certain VT sensing devices. The system provides the pilot

Table 4-7.—AN/AWW-2A and AN/AWW-2B electrical fuzing system components.

Component		Function
AN/AWW-2A	AN/AWW-2B	
Amplifier-Power Supply AM-4708/AWW-2A	Amplifier-Power Supply AM-4708A/AWW-2A	Generates d-c and RF voltages required for electrical fuze arming and control.
Control Box, Fuze Function C-8147/AWW-2A	Control Box, Fuze Function C-8213/AWW-2B	Provides selection of electrical fuze arming and detonation time delay.
Mount, Electrical Equipment MT-3804/AWW-2A	Mount, Electrical Equipment MT-3804/AWW-2A	Provides mounting for amplifier-power supply.

with a means for selecting one of four different voltage/polarity combinations which are required for the operation of d-c bomb and missile fuzes.

The AN/AWW-4 FFC components consist of Power Supply PP6419, adapter mount, and either Control Box C8441 or C8442. Except for the A-7E aircraft, the power supply is physically and electrically compatible with any aircraft currently equipped with the Fuze Function Control Set AN/AWW-1, -2A, or -2B, only with the use of an adapter mount. The control box is a plug-in unit which is installed in the cockpit and is directly interchangeable with the control units of AN/AWW-1, -2A, or -2B. Control Boxes C8441 and C8442 differ only in the voltage requirement for the face lighting (C8441 is used in aircraft with 28-volt a-c/d-c lighting systems and C8442 for aircraft with 5-volt a-c/d-c lighting systems).

Electrical energy (d.c.) is supplied to the weapon fuzes via aircraft wiring, the bomb arming unit in the bomb rack, and circuitry within the bomb or missile. Various bomb rack arming assemblies can be used with the AN/AWW-4, but all employ a common design which denies any voltage to the bomb until it has actually separated from the rack. The electrical signal selected by the pilot is supplied to the bomb through an interconnecting cable during the first few inches of fall of the bomb.

There are two types of d-c electric bomb fuzes currently in use. They are the M990E series which provides only a single arming/functioning delay and the MK344/376 series which provides an option of several functioning delays. The fuzes used in Bullpup and Walleye missiles also provide several functioning delay options that may be selected by use of the AN/AWW-4 FFC.

When the single delay M990E series fuzes are controlled by the AN/AWW-4, only the VT position (+300V) may be used. The application of any other voltage/polarity can cause a malfunction or erratic operation of the fuze. With the multiple option fuzes, the pilot sets the desired delay into the fuze by selection of the appropriate function switch setting on the AN/AWW-4 control box.

VT sensing elements used in conjunction with electric bomb fuzes are electrically initiated by application of a specific voltage. The newer VT elements (Mk 43) require +300 volts d.c. for electrical initiation and can be controlled by the AN/AWW-4 by selection of the VT option position. The older VT elements (M20/M20A1) require an RF signal and therefore cannot be controlled by the AN/AWW-4.

The control box (C8441 or 8442) provides the pilot with a means of controlling and checking the operation of the power supply. The front panel of the unit contains a five-position rotary function switch (Safe, VT, INST, DLY 1, and DLY 2), a pushbutton HVDC TEST switch, and a HVDC indicator lamp.

Detailed information on the Fuze Function Control Set AN/AWW-4 may be found in NavAir 11-5-122.

Test Equipment

Test Set AN/AWM-42 is used primarily for conducting flight line checks of installed AN/AWW-4 equipment. It may also be used for bench testing purposes; however, a volt-ohm meter will permit more accuracy and

Table 4-8.—Control/indicator functions for the AN/AWW-2A/B electrical fuzing system.

Index No.	Control/indicator	Function
1	Arming delay switch (ARMING DELAY)	Provides selection of arming delays.
2	Firing delay switch (FIRING DELAY)	Provides selection of impact delays.
3	Interlock override switch (INTERLOCK OVERRIDE SW)	ON—permits use of 2-second arming delay on arming delay switch. OFF—prevents use of 2-second arming delay on arming delay switch. (All other positions on arming delay switch are available.)
4	High voltage DC light (HVDC)	ON—indicates AN/AWW-2A system is ready to operate.
5	Function selector switch (FUNCTION)	Energizes system and selects fuzing mode.
6	HVDC test switch (HVDC TEST)	Pressed to check ready condition of AN/AWW-2A system.
7	Interlock override switch—(INTERLOCK OVERRIDE SW)	ON—permits use of 5.5 second arming delay on arming delay switch. OFF—prevents use of 5.5-second arming delay on arming delay switch. (All other positions on arming delay switch are available.)

should be used if available. Instructions for operating this test set are contained in NavAir 16-30AWM-42-1.

An alternate test set, AN/AWM-31, may be used if an AN/AWM-42 is not available.

BOMB ARMING UNITS

Bomb arming units are electromechanical devices for use in transferring arming signals from the aircraft's electrical fuzing system to an electrically fuzed aircraft bomb via a Mk 93 wafer switch.

Bomb arming units are installed in bomb ejector racks and the particular arming unit used depends on the bomb rack used. In general, the arming units are engineered to be installed in one type of rack and they are not interchangeable.

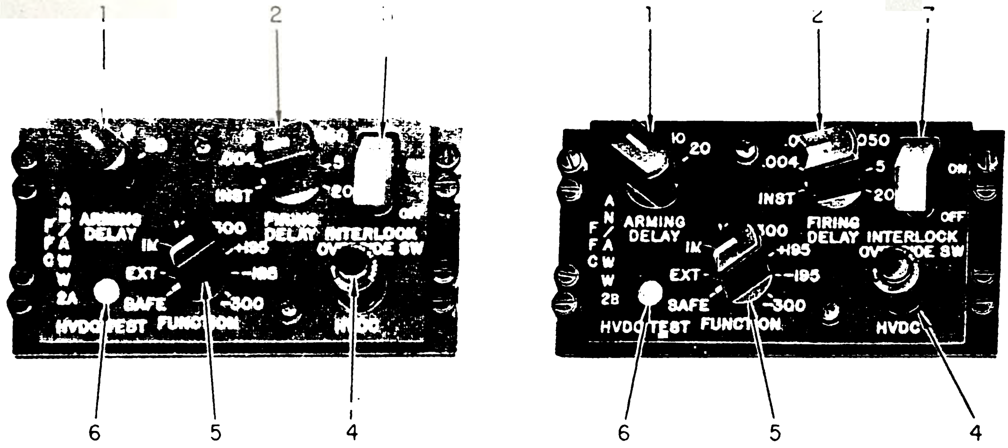
AO 3 & 2, NavPers 10345-C, and NavAir 11-5-101 contain additional information on bomb arming units and the bomb rack with which each is used.

MK 122 ARMING SAFETY SWITCH

The Arming Safety Switch Mk 122 was designed to provide a quicker, safer, and more economical means of completing the electrical fuzing system connection between the aircraft's bomb rack (BRU 10/A) and bomb than a bomb arming unit.

The Mk 122 (fig. 4-15) is attached to the bomb body by means of a retaining nut where it mates with the bomb's electrical conduit which in turn connects to the fuze wells of the bomb. A coaxial cable connects the Mk 122 to a quick-disconnect connector which in turn is connected to the Mk 39 bomb arming unit's electrical connector receptable in the bomb rack. A lanyard pin connects to the top of the Mk 122 which causes the Mk 122 to block the entry of voltage into the bomb until the lanyard is pulled. The lanyard is equipped with a tab which is connected to the bomb rack after the bomb is loaded and ready for launch.

On release the lanyard is retained by the bomb rack which pulls the lanyard pin, allowing



AO.512

Figure 4-11.—AN/AWW-2A and AN/AWW-2B electrical fuzing system controls and indicator functions.

the MK 122 to pass the arming and firing signals to the bomb fuzes. As the bomb falls, the coaxial cable is pulled from the quick-disconnect connector freeing the bomb from the aircraft.

Th MK 122 arming safety switch is installed in the bomb (it is compatible with all current fleet usage bombs) by the assembly crew in a RADHAZ-free environment.

Safety

Do not pull the lanyard during handling and loading. If you do and it breaks away from the MK 122, discard the entire MK 122 arming safety switch so that it will not be used on a bomb.

When in a RADHAZ environment, and the lanyard is pulled enough to withdraw the lanyard pin (fig. 4-15), immediately notify EOD personnel for bomb disposition. If the lanyard is pulled in a RADHAZ-free area, merely replace the MK 122 with a new unit.

M61A1 20-mm AUTOMATIC GUN

The M61A1 20-mm Automatic Gun (fig. 4-16) is a six-barrel, rotary-action mechanism operated by means of an external power source such as an electrical motor or a hydraulic drive unit. The M61A1 gun is a multiuse weapon capable of firing 4,000-7,200 shots per minute. (See table 4-9 for characteristics.) The M61A1 is currently used in the F-4E and A-7E aircraft with planned use in the F-14 also. Another use is in the GPU-2/A Lightweight Gun Pod.

The M50 series ammunition is used with the M61A1 gun and is susceptible to radiation hazard (RADHAZ); it requires the use of a RADHAZ shielded link.

Detailed information on the M61A1 is contained in NavAir 11-95 M61A1-1. Information on the A-7E internal installation, troubleshooting, and maintenance is contained in NavAir 01-45AAE-2-14.

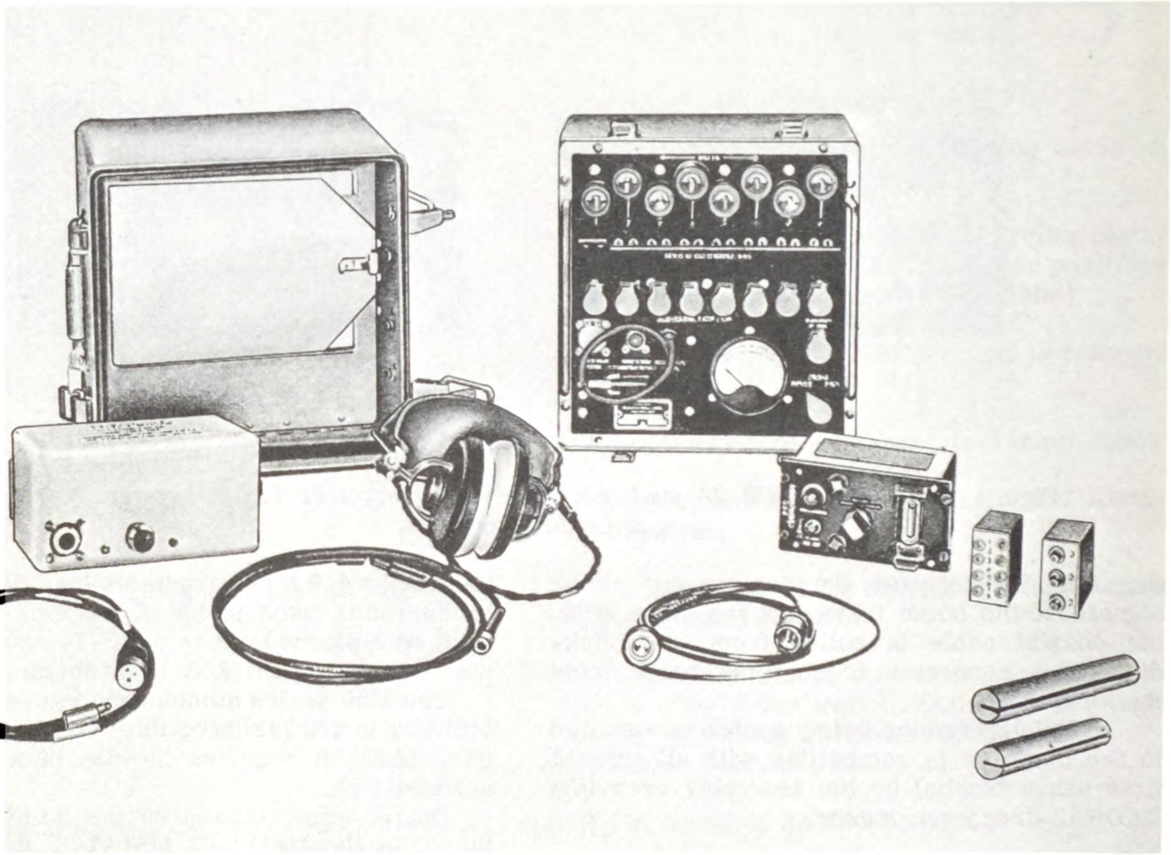
DESCRIPTION

The primary parts of the gun are the barrels (6), housing assembly, and rotor assembly. As the rotor turns in a counterclockwise direction, interaction between the rotor and housing (by means of cams and gearing) causes the various actions to take place. There are six actions or operations—feed, chamber, lock and fire, unlock, extract, and eject.

Components

A brief description of some of the M61A1 20-mm Automatic Gun components is provided in the following paragraphs.

MUZZLE CLAMP ASSEMBLY.—The muzzle clamp assembly is positioned at the outer end of the barrels to restrain individual barrel



AO.513

Figure 4-12.—Test Set AN/AWM-4.

movement during firing. It is positioned against the shoulders on the barrels and secured by the pressure of the self-locking nut assembly against the opposite side of the shoulders.

MID-BARREL CLAMP ASSEMBLY.—The mid-barrel clamp assembly is positioned near the center of the barrels, with the clamp tabs engaged in the slots of the stop shoulders on the barrels. The clamp is secured in this position by rotating the locking disk to the locked position. The rotation of the gun and barrel detents prevent the clamp from unlocking.

BARRELS.—The weapon incorporates six barrels that are fitted with rifled inserts. They are supported by the stub rotor which is attached to the rotor body. The three rows of interrupted locking lugs on the barrel engage similar interrupted locking lugs in the rotor to secure the barrels. Three knurled bands near the center of the barrels provide a convenient gripping surface for ease in installation and removal of the barrels from the rotor.

RECOIL ADAPTER.—The recoil adapters are mounted on the bearing retainer and provide the front mounting for the gun. Alternate locations of the recoil adapters, with respect to the weapon axis, are available as the bearing retainer may be mounted to the housing in increments of 60 degrees. The adapters reduce the amount of recoil and counterrecoil forces transmitted to the supporting structure when the weapon is fired.

FIRING CONTACT ASSEMBLY.—The firing contact assembly is mounted to the housing so that the connector is above the housing and the spring-loaded cam below. The contact assembly provides the necessary path for the firing current to enter the housing and reach the

Table 4-9.—Characteristics.

Gun	
Rotation	Counterclockwise viewed from breech end
Drive	External electric motor or hydraulic unit
Caliber	20-mm
Length overall	Approximately 72 inches
Weight	283 pounds
Solenoid operating voltage	28 volts d.c.
Solenoid resistance	1 ohm
Firing voltage	330 volts d.c.
Barrels	
Number of barrels	6
Length	60 inches
Number of Lands	9
Twist	Right-hand gain twist
Rate of fire	4,000 to 7,200 rounds per minute
Ammunition	20-mm electric detonation
M51A1B1	20-mm dummy cartridge
M53	Armor piercing incendiary (API)
M54	High-pressure test cartridge (HPT)
M55A1	Government standard 20-mm cartridge
M55A2	20-mm target practice ball cartridge (TP)
M56A3	High explosive incendiary (HEI)

breech bolt assembly. This path is through the connector to the conductor, to the insulated insert in the contact cam assembly, and to the breech bolt assembly.

CLEARING SOLENOID ASSEMBLY.—The clearing solenoid assembly mounts near the back of the gun housing and is linked to and controls the movement of the clearing sector assembly.

CLEARING SECTOR ASSEMBLY.—The clearing sector assembly is linked to and controlled by the clearing solenoid assembly. When the solenoid is activated, the sector arm diverts the bolt assemblies into the clearing cam path.

GUIDE BAR.—The guide bar is located on the gun housing. It guides the rounds into and out of the extractor lip on the bolt assemblies.

BREECH BOLT ASSEMBLY.—The breech bolt assembly picks up a round as it enters the gun, transports it to the firing chamber, and locks it into firing position, transmits the firing voltage to the primer of the round, and returns the empty case to the guide bar where it is cammed out of the gun. An extractor lip on the front of each bolt assembly engages the rim of a round and controls the round throughout the various actions.

There are six breech bolt assemblies used in the gun. Guide slots or grooves on the side of the bolt body permit it to slide on the rotor tracks. The bolt roller shaft determines the position of the bolt as it follows the main cam path or the clearing cam path in the housing.

ROTOR ASSEMBLY.—The rotor assembly is a major unit of the gun. The front section or stub rotor provides support for the six barrels. The main body of the rotor contains the rotor tracks, drive gear, and the locking lugs to lock the barrel in place.

The rotor tracks support the breech bolt assembly and provide a guide for the forward and backward movement of the bolt. There are six sets of rotor tracks attached to ribs along the rotor body. Each set contains a front, center, and rear or removable track. The removable

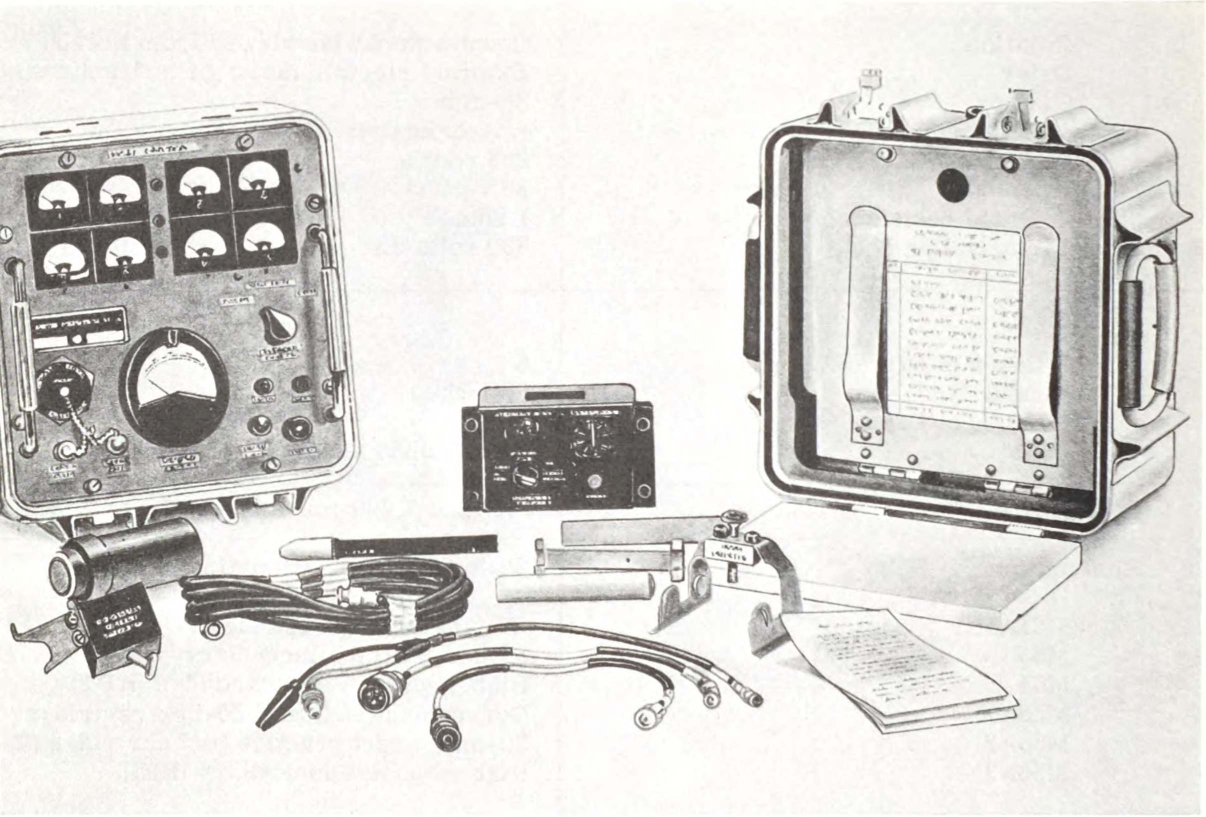


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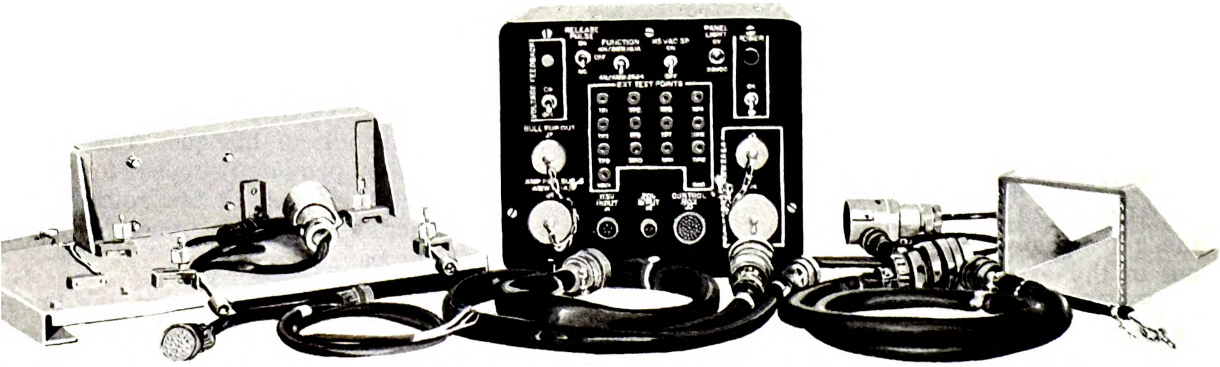
Figure 4-13.—Test Set AN/AWM-31.



AO.515

Figure 4-14.—Test Bench Harness AN/AWM-11A.

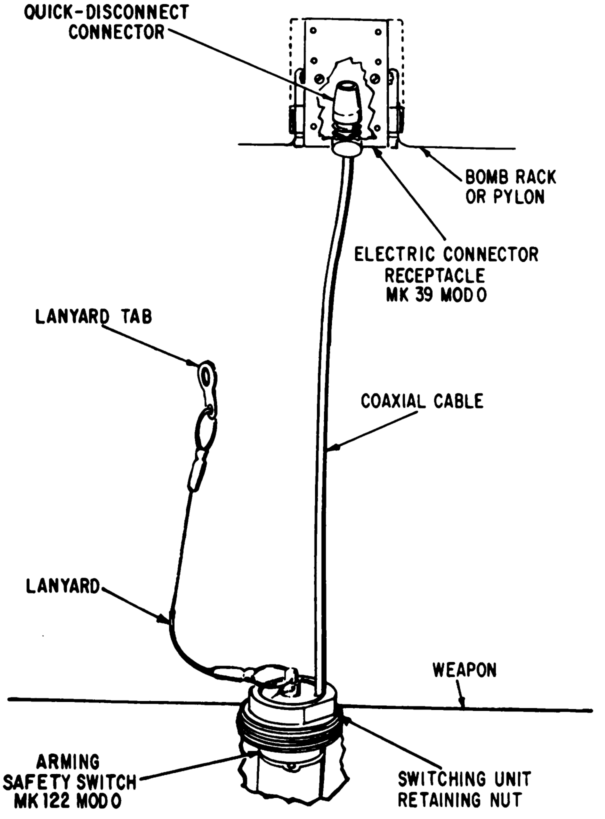

QUICK-DISCONNECT CONNECTOR
BOMB RACK OR PYLON
ELECTRIC CONNECTOR RECEPTACLE MK 39 MOD 0
LANYARD TAB
COAXIAL CABLE
LANYARD
WEAPON
ARMING SAFETY SWITCH MK 122 MOD 0
SWITCHING UNIT RETAINING NUT
AO.516

Figure 4-15.—MK 122 arming safety switch connection.

track permits installation or removal of a bolt assembly for serving or replacement.

Front support of the rotor assembly is a double row ball bearing and rear support is a neddle bearing located inside the rotor body. The end plate of the gun, or a hydraulic drive unit, provides the needle bearing with a stationary inner race for rear support of the rotor.

The rotor assembly is driven by an external source. This source may be either an electric motor, which is geared to the rotor assembly drive gear, or a hydraulic drive unit, which replaces the gun end plate on the rear of the housing and engages the internal spline of the rotor.

HOUSING ASSEMBLY AND ASSOCIATED PARTS.—The housing assembly is a major unit of the gun and consists of an upper section and a lower section assembled as a unit. It provides the main cam path to control the movement of the breech bolt assemblies. The elliptical shape of the main cam path causes the forward and backward movement of the bolt assemblies. The clearing cam path is circular in shape and is located at the rear of the housing. It provides a path for the bolt assemblies during the clearing cycle of the gun. The housing cover, when in the closed position, forms a part of the clearing cam path.

There are several associated items which are mounted directly to the housing. They are the locking and unlocking cams, roller guide, indexing pin assembly, and housing cover.

Operation

The operation of the gun may be divided into two distinct cycles; the firing cycle and the clearing cycle which are discussed in the following paragraphs.

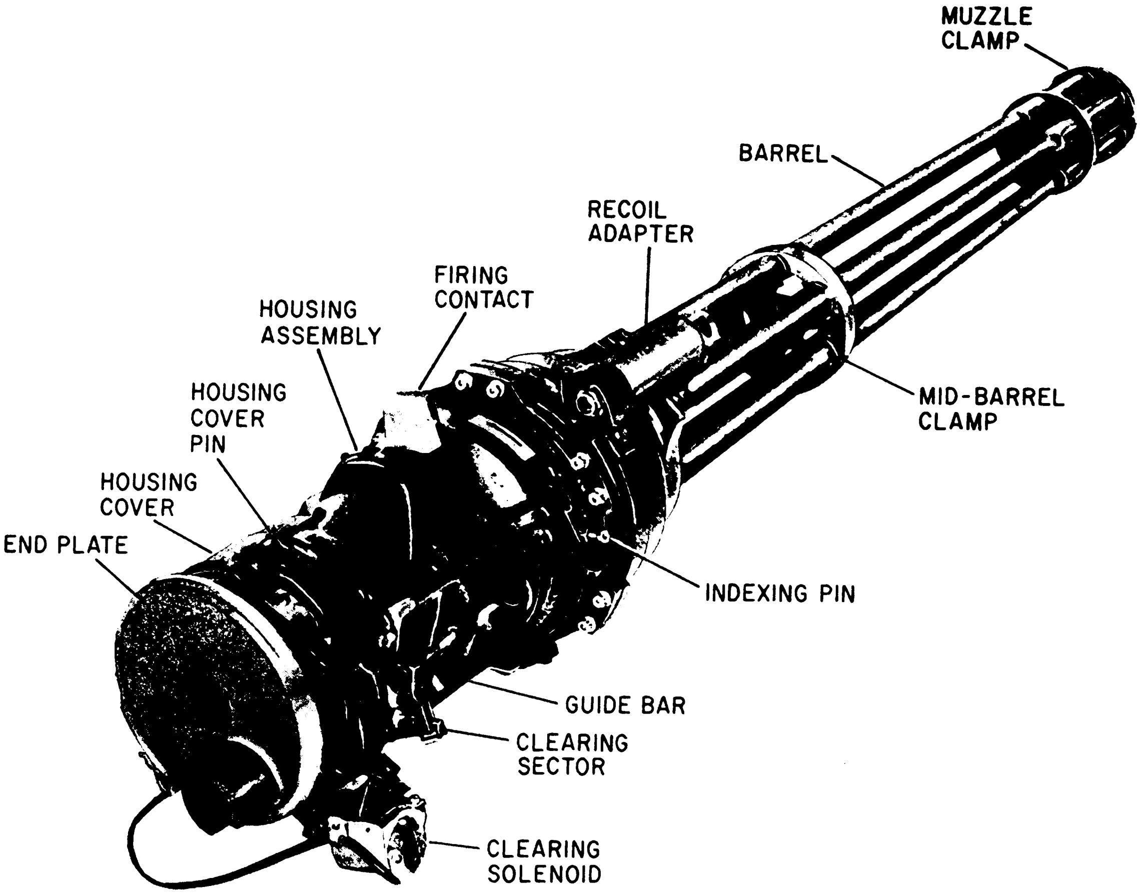
FIRING CYCLE.—The firing cycle begins when power is applied to the firing contact assembly and drive unit simultaneously.

As viewed from the rear, the rotor revolves in a counterclockwise direction. The ammunition is received from an external source and guided into the extractor lip on a breech bolt assembly by the guide bar fingers. The bolt roller shaft follows the main cam path, moving the bolt assembly forward along the rotor tracks chambering the round.

As the breech bolt assembly enters the front dwell area of the main cam path, the locking cam forces the bolt shaft down, locking the bolt in the front locking well of the rotor. The insulated portion of the contact cam in the firing contact assembly depresses the firing pin cam in the breech bolt assembly, moving the firing pin forward against the primer of the round. The conductor portion of the contact cam then makes contact with the firing pin cam, allowing a firing voltage to pass through the firing pin and discharging the round.

After the round has been discharged, the breech bolt assembly remains locked through the locking cam period while the projectile travels through the barrel and the barrel pressure is reduced. The unlocking cams then lift the bolt shaft, retracting the bolt locking block and unlocking the bolt.

As the main cam path guides the breech bolt assembly rearward, the empty case is removed from the chamber by the extractor lip of the



AO.517

Figure 4-16.—M61A1 20-mm automatic gun.

bolt assembly. The bolt assembly travels back along the rotor tracks until the guide bar removes the empty case from the bolt extractor lip and ejects it from the gun. The bolt assembly then travels along the rear cam dwell area and into position to receive the next round.

The breech bolt assembly has now completed a full firing cycle through the elliptical-shaped main cam path. All six bolt assemblies will repeat this cycle until the clearing solenoid is actuated, causing the gun to enter a clearing cycle.

CLEARING CYCLE.—The clearing cycle begins when the clearing solenoid is activated. This depresses the clearing sector arm to the gun housing in a ready position. The first bolt assembly passing the arm triggers the actuating pin, allowing the sector arm to continue to the clearing mode position and diverting the succeeding bolt assemblies into the clearing cam path.

As the breech bolt assembly picks up a round at the guide bar, the clearing sector depresses the bolt roller shaft, locking the bolt assembly in the real locking well of the rotor. While locked in this position, the bolt assembly cannot follow the main cam path. The clearing cam path is of a lesser depth than the main cam path and keeps the bolt roller shaft depressed, firmly locking the bolt assembly in the rear of the rotor body.

The gun continues to receive rounds during the clearing cycle. Each bolt assembly remains positioned at the back of the rotor during rotation. Unfired rounds are ejected by the guide bar cam fingers. When the clearing solenoid is deactivated, the clearing sector cam pivots out of the main cam path and will follow the clearing cam path. This allows the rear locking well to force the bolt locking block upward. The bolt roller shaft will now follow the main cam path allowing the gun to be fired.

The gun may also be cleared manually, if desired. This may be accomplished by manually pivoting the clearing sector cam into the main cam path while turning the rotor by hand.

A-7E M61A1 INSTALLATION

The A-7E employs the M61A1 as internal armament. As stated earlier, the M61A1 has the ability to fire either 4,000 or 7,200 rounds per minute; but the M61A1 as used with the A-7E permits selective firing of 4,000 (Gun Low Switch position) or 6,000 (Gun High Switch position) rounds per minute. The controlling factor lies with the A-7E's PC-2 hydraulic system and the aircraft's drive unit.

Description

The A-7E's gunnery system consists of an M61A1 gun, a linkless ammunition handling system, a hydraulic gun drive system, a gun gas purge system, and an electrical control system. The M61A1 gun and its operation were discussed earlier in the chapter. This discussion is not repeated in this section. The ammunition handling system uses an endless conveyor that transports the rounds of ammunition from the ammunition drum (fig. 4-17) to the gun and returns spent cases and cleared rounds to the drum. The hydraulic gun drive system supplies power to drive the gun and ammunition handling system. (This power is arrived from the aircraft's PC-2 hydraulic system.) The electrical control system controls the application of voltage to the applicable switches, relays, solenoids, and firing contact assembly. The electrical control system also controls the application of voltage to the gun gas purge system electrical components. The gun gas purge system consists of components necessary to force explosive gun gases from the gun and ammunition drum compartment.

Operation

If ammunition is present, the gunnery system may be placed in operation any time the master arm switch is on, GUN HIGH or GUN LOW rate switch is selected, and the landing gear handle is in the up position or the armament safety disable switch is actuated. If ammunition is not present, or has been expended to the point where the last round switch is released, no further firing can be initiated after completion of the firing cycle.

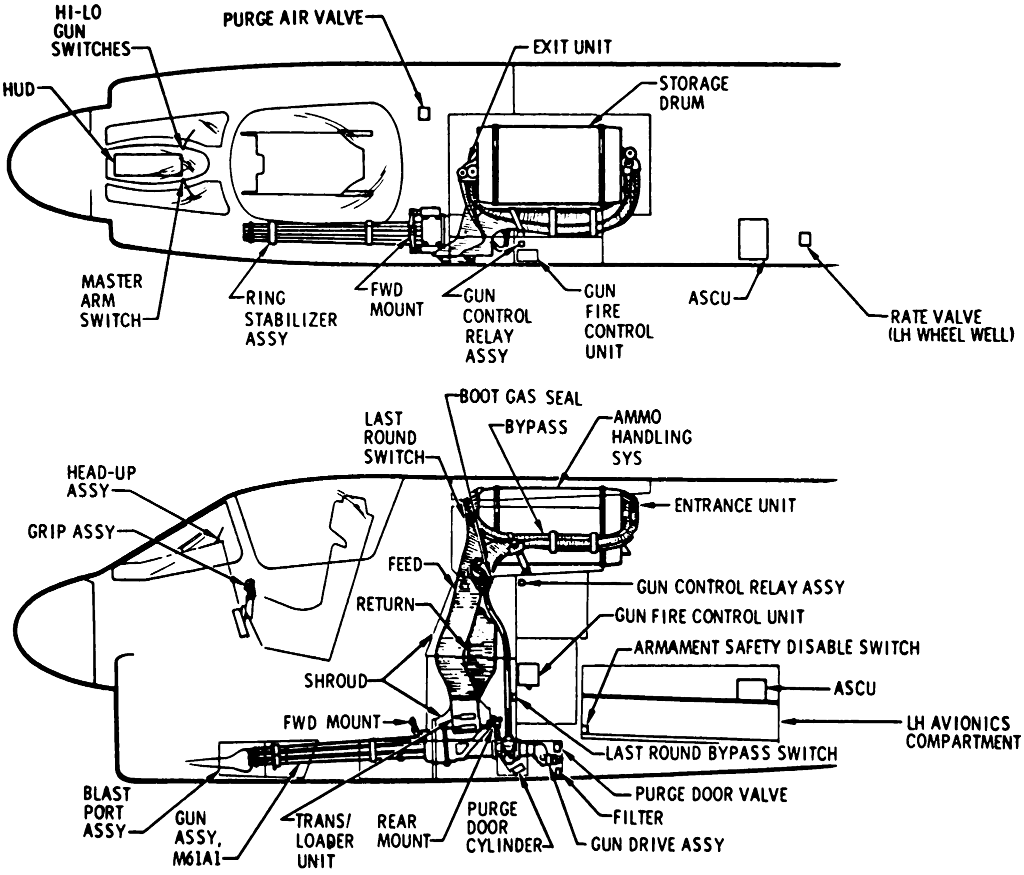
Interlocks in the aircraft wiring prevent the gun from being fired when the aircraft is on the ground. To bypass the interlock for ground firing or operational checkout, the master arm switch must be on and the arm safety disable switch momentarily closed. With the interlock bypassed, master arm signals are applied to the gunfiring logic and master arm logic in the gun control unit. Depressing the trigger switch to the second detent position applies 28 volts d.c. to the purge door valve, gun gas purge valve bypass relay, and the last round bypass switch. The last round bypass switch must be held in the BYPASS position to allow ground cycling of the gun system when the last round switch is released.

In normal in-flight operation (landing gear handle up) , relays are energized to set up a circuit between the master arm switch, trigger switch, and the fuselage gun rate switches. The firing speed of the gun is controlled by the dual rate flow control valve. The fuselage gun rate switches are used to position the control valve to allow either 6,000 (GUN HIGH) or 4,000 (GUN LOW) rounds per minute firing. Depressing the trigger to the first detent position, with camera switches on, places the Strike Camera KB-18A in operation. Depressing the trigger switch to the second detent position places the gun gas purge system into operation and starts the gunfiring cycle.

Ammunition Handling System

The ammunition handling system (fig. 4-18) stores the ammunition (approximately 1019 rounds), delivers and feeds it to the gun, receives expanded cases and cleared rounds from the gun, and returns them to the ammunition drum. The components of the system are as follows:

1. An ammunition drum unit assembly which stores 900 rounds of live ammunition and expended cases.
2. An exit unit which removes the live ammunition or expended cases from the ammunition drum and places them in the feed chute conveyor elements (holds an additional 119 rounds).



AO. 518

Figure 4-17.—Gun system, general layout.

3. An entrance unit which removes live ammunition or expended cases from the return chute conveyor elements and places them in the ammunition drum unit assembly.

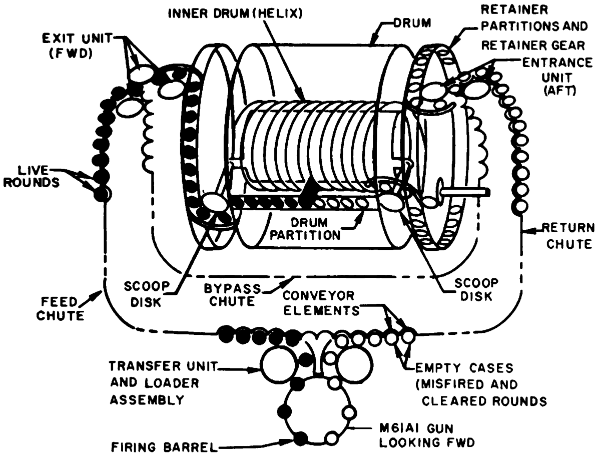
4. A feed chute and return chute containing conveyor elements which transport ammunition to the transfer unit and returns expended cases and cleared or misfired rounds to the ammunition drum unit assembly.

5. A bypass chute which guides empty conveyor elements from the entrance unit to the exit unit.

6. A transfer unit which feeds cartridges from the conveyor elements to the gun and transfers expended cases and cleared or misfired rounds from the gun to the conveyor unit.

On aircraft with airframe change No. 110, during ammunition loading, the loader unit loads live ammunition into conveyor elements, removes expended cases and unfired ammunition from the conveyor elements and rebelts cases and unfired ammunition.

During gunfiring, cartridges are placed in the conveyor as it passes through the exit unit on the ammunition drum. The conveyor transports the cartridges through the feed chute to the transfer unit, which picks up the cartridges and feeds them into the gun. The transfer unit also unloads empty cases, cleared or misfired cartridges from the gun, and places them back in the conveyor. The conveyor transports the cases and cartridges through the return chute to the



AO. 519

Figure 4-18.—Conveyor system.

opposite end of the drum (entrance end) where they are removed from the conveyor by the entrance unit and inserted into the drum. The conveyor now empty, passes through the bypass chute, around the drum unit assembly to the exit unit, and again receives cartridges to transport to the gun.

The system operates without the use of standard ammunition links (except while loading). The function normally performed by ammunition links is performed by the conveyor element when ammunition is moving from one system component to another. In the ammunition drum, the cartridges are controlled mechanically at all times, thus eliminating the need for links.

Power to operate the ammunition handling system is provided by the gun drive unit, thus insuring that the system components and the gun are always synchronized. Power to operate the ammunition drum and entrance and exit units is applied through a flexible shaft coupled between the drive unit assembly and the drum drive assembly. The gun and transfer units are powered through a gun drive assembly connecting the drive unit assembly to the drive gear in the gun.

Gun Gas Purge System

The gun gas purge system is placed in operation when the trigger switch is depressed to the second detent position. When the logic circuitry is satisfied, 28 volts d.c. from the ASCU is applied to the gun gas purge door valve, which directs the hydraulic flow to the actuator to open the gun gas purge door. As the door opens, the gun gas purge door interlock switch is actuated and applies power to the gun gas purge valve. As the purge valve opens, the gun gas purge valve interlock switch completes the circuit to a relay in the hydraulic motor solenoid circuit and to a relay in the firing voltage circuit.

Purge air, from the low pressure bleed system of the aircraft, then flows into the gun compartment above the shroud, into the ammunition drum compartment, and into the forward barred section. The purge air forces any explosive gases from the compartments, and the suction created by the open purge door draws the gases out via the compartment located below the shroud.

The gun gas purge system remains in operation for 20 to 30 seconds after the trigger switch is released. Interlocks in the guns electrical control circuits prevent the gun from firing should the gun gas purge system fail.

M61A1 LOADING (A-7E INSTALLATION)

Procedures for loading the M61A1 as installed in the A-7E are provided in detail in NavAir 01-45AE-75 and should be a part of the training program for personnel associated with this type aircraft. To familiarize all AO's with the M61A1 loading, the A-7E procedures are briefly described in the following paragraphs.

Aircraft Preparation

The following conditions, pertaining to the aircraft, must be met prior to commencement of loading any store or weapon:

1. Ordnancemen familiar with the external hazards of the aircraft (jet intake/exhaust, exhaust ports, tail hook, etc.)
2. Firefighting equipment available and all fire hazards removed from the immediate area.
3. Aircraft positioned in a designated loading area with adequate clearance for loading and handling equipment.
4. Aircraft wheels chocked and tiedowns installed as required.
5. Landing gear downlocks installed.
6. Canopy wingfold jury struts installed as required.
7. Ground handling equipment available and ready for use.
8. Aircraft serviced as required.

9. Aircraft system checks, other than armament checks, completed.
10. Weapons or stores assembled and ready for loading before delivery of aircraft.
11. Aircraft in ready condition to receive weapon accessory equipment and weapons/stores.
12. Armament safety precautions complied with. Required safety pins installed.
13. Aircraft grounded with low resistance conductor connected between aircraft grounding point and common ground.
14. All cockpit armament selectors on left and right cowling are in the out position (deselected) and control switches are positioned to OFF or SAFE as specified in the conventional weapons loading manual or stores reliability card for the type weapon/store being loaded.

Manual Loading

Manual loading of the M61A1 A-7E internal installation is accomplished in accordance with procedures outlined in NavAir 01-45AE-75, A-7E Conventional Weapons Loading Manual. This manual lists the special tools and equipment required to safely load the gun system.

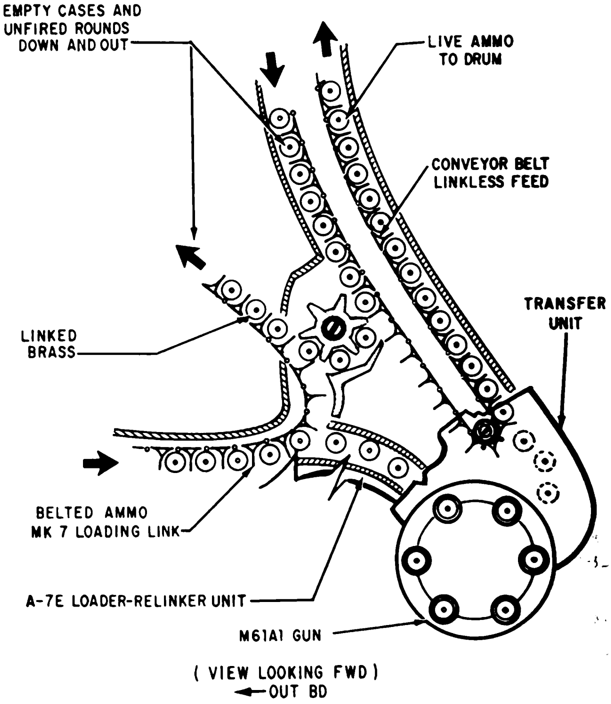
The M50 series ammunition belted with the Mk 7 RADHAZ shielded link is used. The links are only used to facilitate loading as the gun system does not require the ammunition to be belted. In general, the ammunition is belted in a RADHAZ safe area, placed in ammunition boxes, and delivered to the aircraft to be loaded; the boxes are placed on a trailer (or other handling equipment) so that the boxes are alined with the gun and approximately 20 to 24 inches away.

A hand crank is used to drive the gun which in turn pulls the ammunition into the gun system. The hand crank is turned until empty links (or linked brass) start returning from the gun; at this time, a battery powered or aircraft hydraulic drive system may be used, vice the hand crank, to speed up the operation.

After loading is completed, a senior AO must perform a postloading-quality assurance check on the cockpit switches and the gun. Figure 4-19 shows the paths of travel of the ammunition and links during loading. Figure 4-20 shows a typical loading operation.

20-mm Automatic Bulk Loader System

Another means of loading the M61A1 20-mm automatic gun is by the use of the 20-mm automatic bulk loader system. This system is designed to load and download the M61A1 system in aircraft or in the GPU-2/A light-weight gun pod.

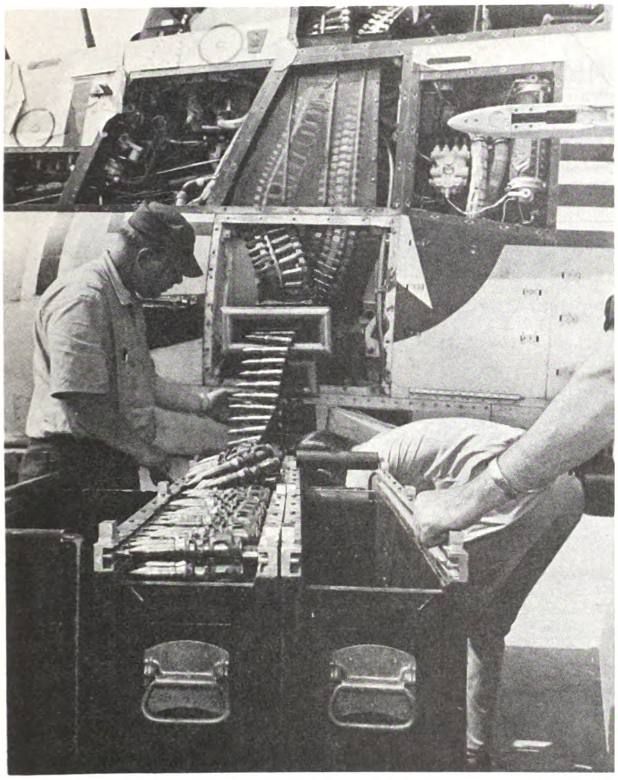

EMPTY CASES AND UNFIRED ROUNDS DOWN AND OUT
LIVE AMMO TO DRUM
CONVEYOR BELT LINKLESS FEED
TRANSFER UNIT
LINKED BRASS
BELTED AMMO MK 7 LOADING LINK
A-7E LOADER-RELINKER UNIT
M61A1 GUN
(VIEW LOOKING FWD)
OUT BD

AO. 520

Figure 4-19.—A-7E loading.

When connected to the aircraft gun system, it can achieve the following:

1. Load at the rate of 350 rounds per minute.
2. Load new rounds into the aircraft and remove empty brass and unfired rounds simultaneously.
3. Load and empty system with any desired mix ratio.
4. Permit partial loading or downloading.
5. The system has a capacity of 1,400 rounds which will load one A-7E system, two F-14 systems, two F-4E systems, or four GPU-2/A lightweight pods.
6. Can be preloaded in a RADHAZ safe area and eliminates the need for ammunition links at any time.
7. Provides automatic sorting of empty brass and unfired rounds when downloading.



AO. 521

Figure 4-20.—Manual loading M61A1 A-7E system.

The system is mounted on an Aero 21B bomb skid as shown in figure 4-21.

Jammed Gunnery System

Because of the high torque applied to the gunnery system, a jam or sudden stoppage must be considered any time the system stoppage has been caused by mechanical interference within the gun or ammunition handling system. The term sudden stoppage is used to differentiate between a firing stoppage caused by mechanical interference and one imposed by electrical or hydraulic failure. Jam or sudden stoppage damage is likely to be more severe at higher cycling rates that at lower rates. However, the actual severity of damage, which cannot be estimated until the damage is assessed, is primarily dictated by the suddenness of the stop.

Considerable damage can be done at loading rates if the stoppage is sudden enough. Any mechanical induced stoppage is to be considered a jam or sudden stoppage regardless of cyclic rate at which it occurred.

OPTICAL SIGHT SYSTEM

The Lead-Computing Optical Sight MX-3146A/A (optical sight) used with the A-6 aircraft is mounted on the top of the instrument panel in the cockpit and automatically provides the pilot with lead angle, inrange indication, and breakaway indications, enabling him to release a store, rocket, or missile at the precise time and heading. (See fig. 4-22.) The optical sight is used as a backup for the vertical display and as the primary means of directing Sidewinder missile attacks. The optical sight projects four optical displays onto the optical sight reflector in the pilot's field of view. These four optical displays consist of a fixed reticle, movable reticle, in-range light, and breakaway light.

The fixed reticle is illuminated by a double-filament lamp and is alined with the armament datum line (ADL) of the aircraft and reflected into the pilot's field of view. The reticle contains a cross with a center dot and two dashed concentric semicircular arcs spaced 50 mils apart. Additional dots are spaced 10 mils apart between and beneath the arcs. During the automatic (AUTO) mode of sight operation, and when used as a night reticle, the arcs and dots will generally be masked at the image-forming source.

The fixed image display, when masked, appears as shown in figure 4-23 (C). When operating the sight in the manual (MAN) mode, the mask will generally be removed so that the arcs and dots may be used for lead angle calculations. With the mask removed, the fixed image appears as shown in figure 4-23 (B). The mask is controlled by the MASK control on the aft right side of the optical sight.

The movable reticle, separately illuminated by its own double-filament lamp, as an interrupted cross containing MIL arcs at the 25-mil and 50-mil positions, that is reflected to the pilot's field of view by the optical sight reflector. (See fig. 4-23 (A).) When the optical sight is operated in the AUTO mode, positioning of the movable image reticle is controlled by the ballistics computer set. By maintaining an aircraft heading that constantly alines the fixed reticle and movable reticle in azimuth, the pilot releases stores at the proper heading. The

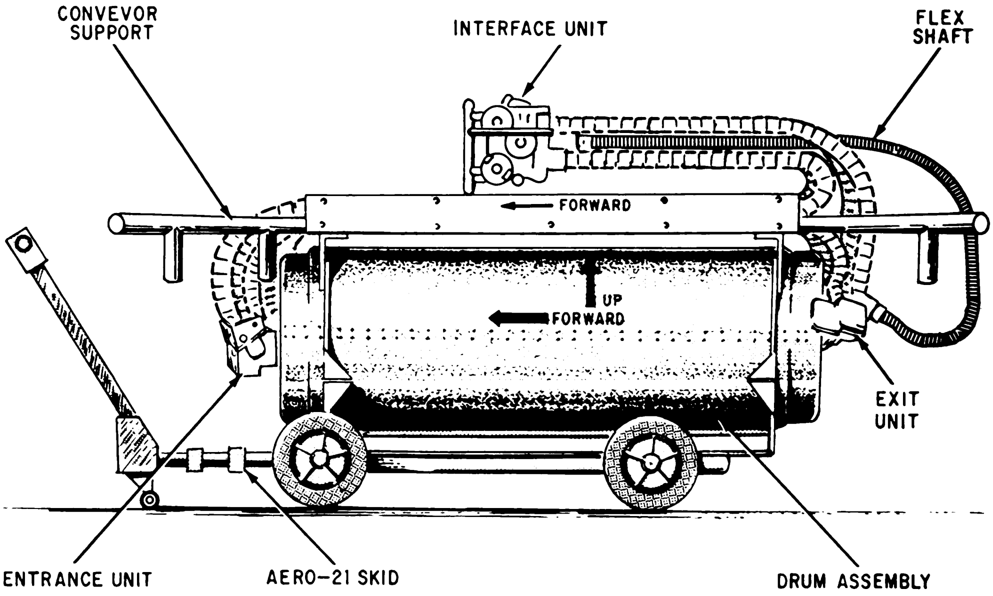


Figure 4-21.—20-mm ammunition bulk loader system.

position of the movable reticle in elevation indicates either the target or the store impact position relative to the ADL of the aircraft, depending on the type of store being delivered. When the optical sight is operated in the MAN mode, the movable reticle is controlled in elevation by the EL thumbwheel.

SIGHT UNIT CONTROL PANEL

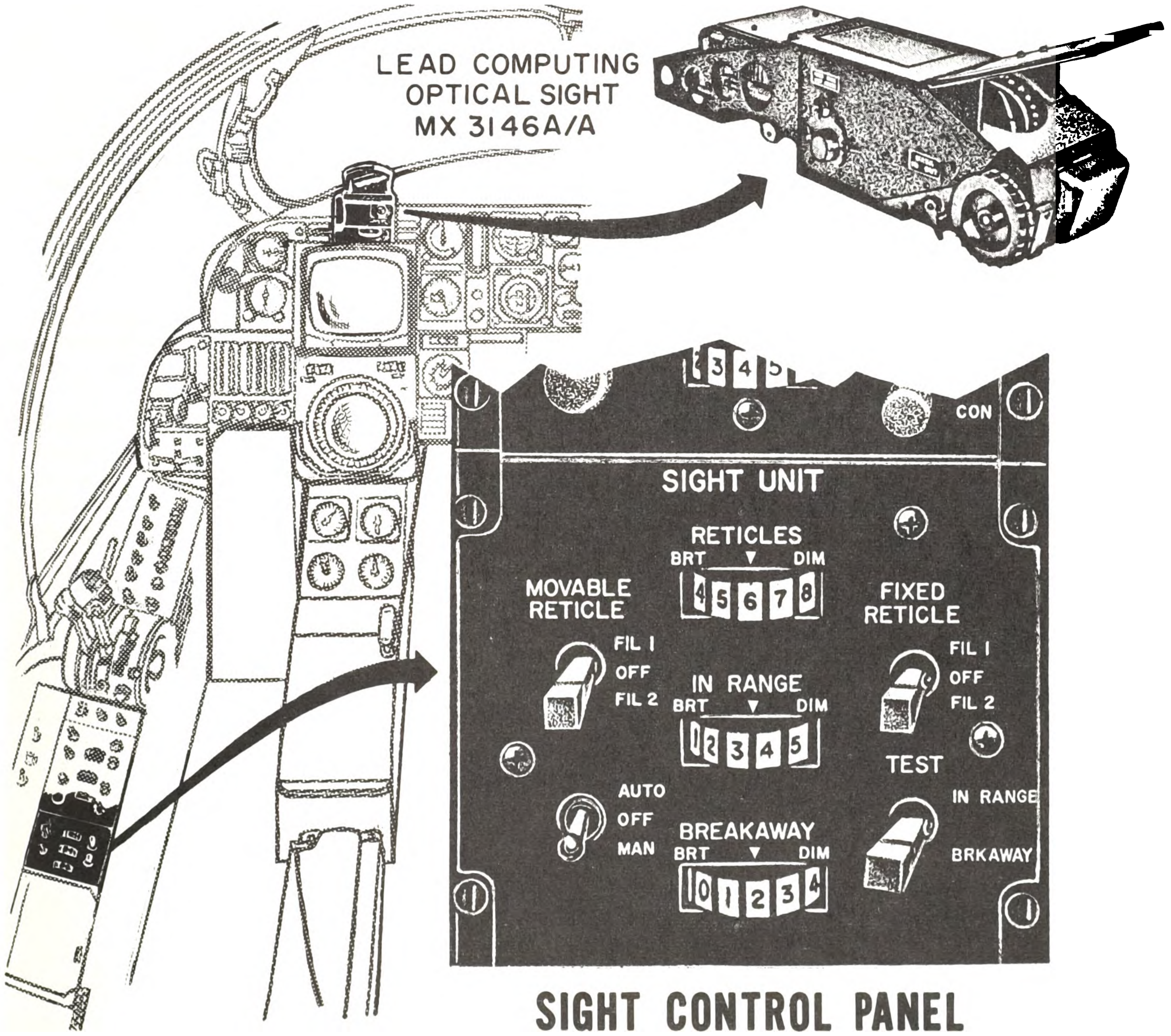
The sight unit control panel on the pilot's left console (fig. 4-22) contains the MOVABLE RETICLE and FIXED RETICLE toggle switches, the AUTO-OFF-MAN toggle switch, the TEST switch, and the RETICLES, IN-RANGE, and BREAKAWAY thumbwheel controls. These switches are the primary controls for the Lead-Computing Optical Sight MX-3146A/A.

THEORY OF OPERATION

The theory of operation for the optical sight is divided into three sections: electronic and electric theory of operation, mechanical theory, and the optical component theory. Since personnel of the AQ rating maintain the sight, only the mechanical theory and optical theory are discussed in this manual.

The optical sight is a single unit consisting of a main assembly, a plug-in transistorized amplifier and power supply assembly, an aft assembly, and a reflector. All exterior metal surfaces are finished in flat black enamel. All primary a-c and d-c power, signal pulses, and synchro-electrical information are supplied to the optical sight through a single receptacle mounted on the main housing. The optical sight has three mounting points: socket type mount forward, and two vertically oriented mounting holes located halfway aft along the length of the unit. With the exception of the EL thumbwheel and the fixed reticle MASK control, all functions of the sight are remotely controlled.

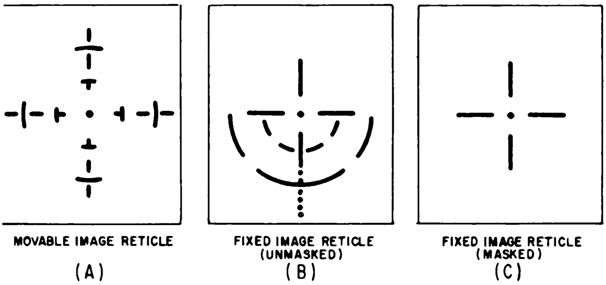
Light rays originated by the fixed image lamp are concentrated by the condenser lens and passed through the fixed image reticle to prism No. 2 and prism No. 1 of the beamsplitter prism assembly and are then collimated through action of the first doublet lens assembly and second doublet objective lens assembly which are component parts of lens and cell assembly. The parallel fixed image reticle light rays received from the collimating lenses are then reflected to the pilot's eyes by the optical sight reflector. (See fig. 4-24.)



AO. 523

Figure 4-22.—Optical sight system.

The MASK control and EL thumbwheel control are on the aft assembly of the optical sight. The MASK control is a lever mechanically coupled to a hinged mask. This mask controls the image exposure content generated by the fixed image reticle and presented to the pilot's view. When the MASK control is in the OUT position, the concentric mil arcs of the fixed reticle are exposed to the pilot's view, enabling him to determine lead angle in the manual mode of operation or when no lead angle information is available from the ballistics computer. When the MASK control is in the IN position, the mask effectively covers all of the fixed reticle except the cross and center dot. The movable reticle and the image cross and dot of the fixed reticle

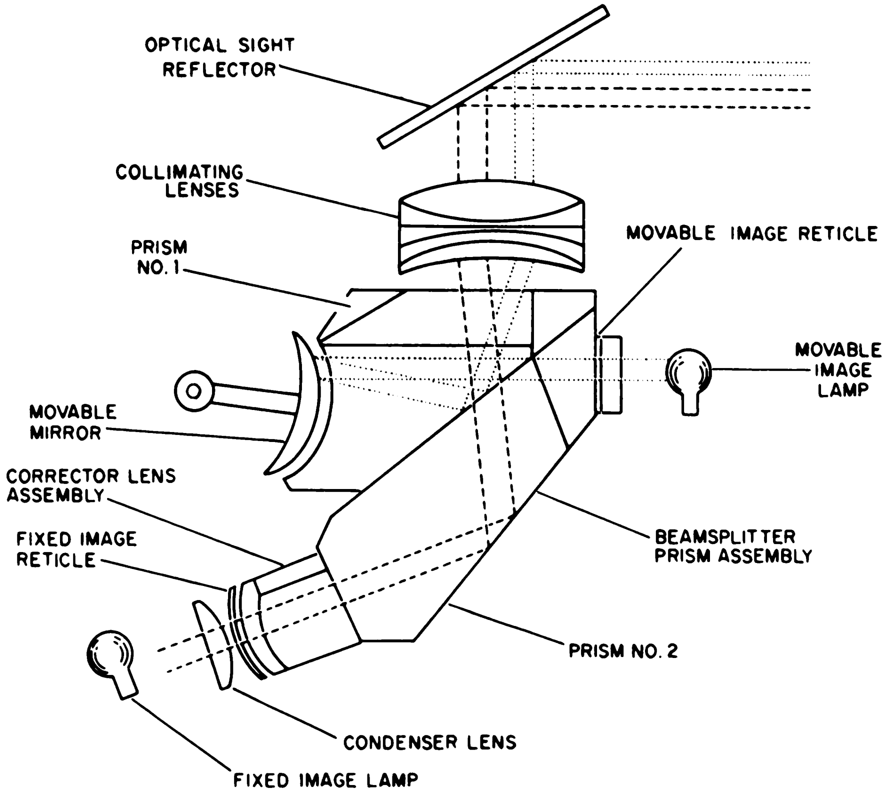

MOVABLE IMAGE RETICLE (A)
FIXED IMAGE RETICLE (UNMASKED) (B)
FIXED IMAGE RETICLE (MASKED) (C)

AO. 524
Figure 4-23.---Optical sight reticle images.

must be alined before weapon release in the MAN mode. The EL thumbwheel is a calibrated thumbwheel mechanically coupled to a synchro transmitter. Operation of the thumbwheel controls the position of the movable image in elevation when the optical sight is in the manual mode of operation. The dial of the thumbwheel is calibrated in 350 mils of elevation down (approximately 20°) and 88 mils of elevation up (approximately 5°) and numbered in divisions of MILS X 10. The dial and identification plate are edge-lighted. Dial illumination intensity is controlled by the aircraft console lights dimmer control.

SIGHT MAINTENANCE

The components of an optical sight system are precision optical and electrical instruments



AO. 525

Figure 4-24.—Optical sight system optical paths.

and must be given due attention to insure that they are functioning properly when installed in operating aircraft. There are certain limitations placed upon the extent of the maintenance to be performed by squadron personnel. Components requiring maintenance within the overhaul or intermediate levels should be returned to the respective shops for reconditioning.

Maintenance of the optical sight consists of servicing, testing, replacing parts, and making minor repairs. Servicing includes the cleaning of the optical surfaces. This information is discussed thoroughly in AO 3 & 2, NavPers 10345-C and should be reviewed.

Troubleshooting

Troubleshooting of the optical sight system consists of isolating troubles to particular components and their subsequent correction or repair. Maintenance of the system is limited to the replacement of reticle lamps, reflector plates, switches, control knobs, and the repair of minor attaching hardware. Disassembly of the sight unit should only be accomplished at intermediate maintenance and overhaul activities.

Operational Check

Testing of the optical sight system is normally a joint effort between the AO's and AQ's. The AQ's responsibility lies primarily with the associated components such as, ballistic computers, amplifiers, and power supplies, while the AO is mainly concerned with the sight unit itself. Delegation of these areas of responsibility may differ in various maintenance activities. However, for the purpose of instruction, only the sight unit is discussed in this manual.

Testing of the sight unit is accomplished by placing the AUTO-OFF-MAN switch to MAN (fig. 4-21), the FIXED RETICLE control to FIL 1, and the MOVABLE RETICLE to OFF. With the masking lever in the OUT position, all of the fixed reticle should appear in the reflector plate (fig. 4-21) and the intensity should vary with the selection of BRT or DIM on the reticle control. With the lever in the IN position, only the cross and center dot should be visible. With both reticles selected, the movable reticle will appear to be superimposed on the fixed reticle. The selectors should then be placed in the FIL 2 position and the above procedures repeated. By moving the AUTO-OFF-MAN to AUTO, the movable reticle assumes positions according to the inputs from the ballistic computer. The elevation thumbwheel should be checked for freedom of movement and travel limits (88 mils UP to 350 mils DOWN). The movable reticle should change positions according to the thumbwheel settings.

The IN RANGE and BREAKAWAY warning lights may be checked by placing a test switch to the respective positions. A yellow flashing light should be observed with the test switch in the IN RANGE position. In the BREAKAWAY position a red flashing light should appear. Intensity of these warning lamps may be varied by individual controls.

CHAPTER 5

SHORE BASED AIRCRAFT ARMAMENT SYSTEMS

Naval aircraft operating from shore bases are primarily utilized in the field of antisubmarine warfare (ASW). Aircraft with which the AO may be associated (working with or in support of) include the P-3A/B/C and helicopers. A recent addition to shore based operations include the OV-10A and helicopter gunships for counterinsurgency operations.

In this chapter, the P-3C, OV-10A, and helicopters are discussed to familiarize all AO's with the various types of ordnance, armament, and gunnery equipment used by these aircraft. Detailed information on the aircraft weapon systems can be found in the NavAirSysCom Maintenance, NATOPS, and Conventional Weapons Loading Manuals for each type of aircraft.

The P-3A/B aircraft is discussed in chapter 19 of AO 3 & 2, NavPers 10345-C. They are similar to the P-3C in the types of suspension equipment, but the weapon releasing and controlling methods are quiet distinguished. Also, the Aero 1B retro ejector and the A/A47D-2 sonobuoy launcher assembly have been deleted from the C model.

P-3C WEAPONS SYSTEM

The P-3C weapons system provides a means of transporting, controlling, arming, and releasing kill and/or search stores for antisubmarine warfare. The weapons system is comprised of two subsystems, the armament (kill store) and the ordnance (search store) subsystems. The armament subsystem refers to equipment used for the carriage and delivery of weapons/ordnance from the 10 wing stations and 8 bomb bay stations. The ordnance system refers to the equipment used for carrying and delivering search stores from the 48 unpressurized and 3 pressurized sonobuoy launcher tubes (SLT) or the free fall chute.

Weapons are defined (for this chapter) as, but not limited to, bombs, depth bombs, mines, torpedoes, missiles, rockets, practice bombs, and special weapons. Search stores are defined as, but not limited to, sonobuoys, bathythermographs, parachute flares, smoke markers, and other pyrotechnic devices. The P-3C NATOPS Manual, NavAir 01-75PAC-1, contains a listing of the authorized weapons that may be carried and/or released from the aircraft.

BOMB EQUIPMENT

Bomb bay equipment consists of the units and components necessary for the carrying, arming, and releasing of stores. These stores are installed on bomb racks which are suspended from removable pylon assemblies mounted across the center of the bomb bay. Each of these basic bomb installations is assigned a bomb station number. Numbers followed by a letter (such as A, B, C, etc.) designate these stations for special capacities or types of stores. In addition, these stations are arranged in pairs: Stations 1 and 2, 3 and 4, 5 and 6, and 7 and 8. As a further identification feature, the stations are grouped into two layers–odd-numbered stations in the upper layer and even-numbered ones in the lower. When the bomb bay is loaded with mixed stores, each pair of stations must be loaded with the same type of store. This is to insure proper clearance between the stores.

The doors of the bomb bay are electrically controlled and hydraulically operated. In emergency situations, the doors may be closed or opened by use of a manual control valve and a hand pump.

The release or jettisoning bomb bay stores may be accomplished by the pilot, copilot, or tatical coordinator (TACCO). Normally, these stores are electrically controlled and released. If, however, an electrical failure occurs in the release system, the stores can be released by a manual release mechanism.

The following paragraphs discuss basic bomb bay configurations and, in addition, some of the important components and their operation.

Configuration

The bomb bay suspension system consists of eight MAU-38/A and three Aero 65A1 bomb racks. These bomb racks are suspended from removable pylon assemblies mounted at various locations across the center of the bomb bay. Different configurations of the bomb bay are made by varying the arrangement of these pylons. A maximum of 20 different stations are possible through the various combinations of pylon assemblies and bomb racks; however, only eight of these stations may be configured at any one time.

The primary pylon assembly (fig. 5-1(A)) consists of two MAU-38/A bomb racks mounted between two pylon ends. A diagonal strut is attached between the pylon ends to maintain a rigid structure. Four sway brace assemblies are provided and are an integral part of the pylon. When the bomb bay is configured in this manner, the bomb stations retain their numerical identity (1 through 8). Figure 5-2 (A) illustrates the bomb bay configured with four primary pylon assemblies.

The alternate pylon assembly (fig. 5-1 (B)) consists of a single MAU-38/A bomb rack mounted between two pylon ends. The pylon is designed to carry an engine starting unit or a nuclear weapon in special instances. Figure 5-2 (B) shows a configuration of two primary pylons containing stores on stations 5, 6, 7, and 8; one primary pylon assembly containing a store on station 4A; and one alternate pylon assembly with a store on station 2A. Alternate pylon assemblies are generally used in combination with other pylon assemblies.

The 500-pound mine pylon (fig. 5-1 (C)) consists of three MAU-38/A bomb racks mounted between two pylon ends. The pylon is capable of suspending and releasing three Mk 50 or Mk 53 mines, or other comparable stores not exceeding 500 pounds. Figure 5-2 (C) illustrates two 500-pound mine pylons installed in the bomb bay.

The 1,000/2,000-pound mine pylon assembly (fig. 5-1(D)) consists of a bomb rack mounted on a one-piece pylon. The bomb rack is essentially an Aero 65A1 modified with Aero 1A adapter mechanisms. The Aero 1A adapters increase the suspension of the Aero 65A1 from 14 to 30 inches and allow the carriage of stores up to 2,000 pounds. A maximum of three of these assemblies can be installed in the bomb bay. The sway braces for steadying the loaded store on this pylon assembly are attached to the bomb bay over head. Figure 5-2 (D) shows a bomb bay configured with three of these pylon assemblies.

Remote Safety Pin System

A bomb bay remote safety pin system is provided in the bomb bay to safety the upper bomb racks during ground operations. This function is accomplished by the remote retraction and insertion of a safety pin in the MAU-38/A bomb rack. The system consists of an insertion/retraction device mounted on each of the upper bomb racks, a torque tube with universal joints and a lever on the forward end of the torque tube. Rotating the lever actuates the insertion/retraction device. Matching holes in the lever and the front support bracket allow the use of the MAU-38/A bomb rack safety pin and streamer to retain the lever in the normal or safe position. A retract spring on the insertion/retraction device returns the safety pin to the retract position when the remote lever is in the normal position.

Manual Release System

The manual release system consists of a manual release handle and a nuclear stores release handle. The system operates through cables connected to a torque tube and a bellcrank system in the bomb bay overhead. As a safety feature, the system is rigged so that lower stores are released before the upper ones. A mechanical interlock on the manual release handle is connected to the bomb bay door mechanism to prevent manual release until the bomb bay doors are fully open. Pulling the manual release handle, with the bomb bay doors open, actuates the lower and then the upper conventional stores. Pulling the nuclear stores release handle operates a stop on the manual release handle allowing the manual release handle to be pulled further, releasing the lower and then the upper nuclear weapons racks.

WING STATIONS

Ten wing stations, numbered 9 through 18 (fig. 5-3), are provided for carrying and releasing

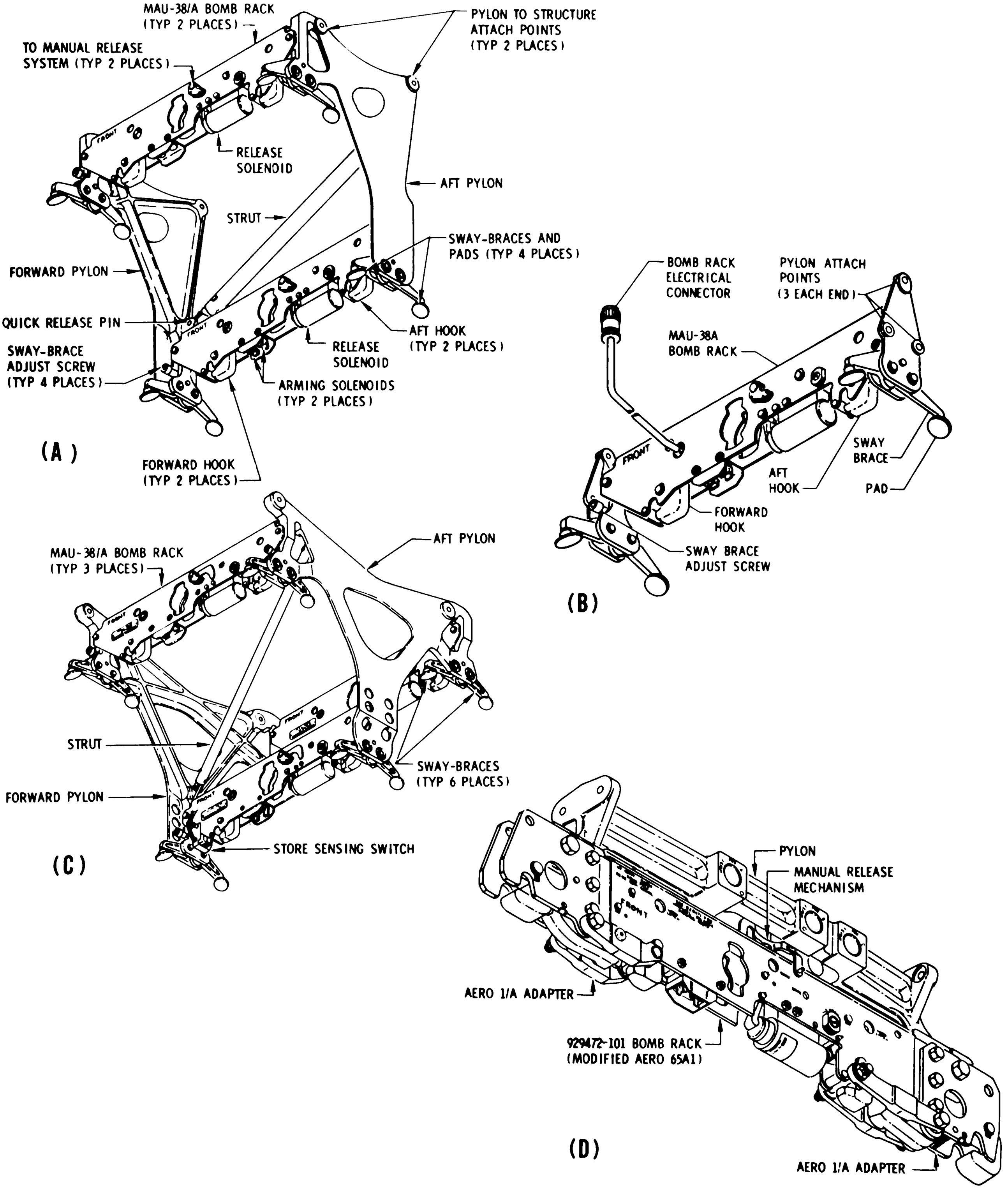
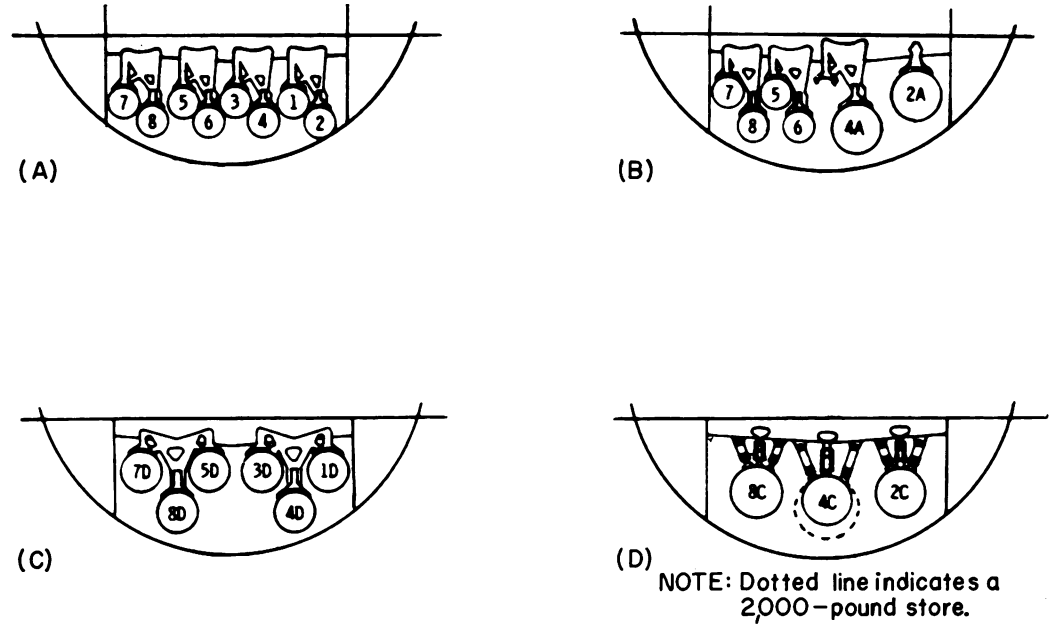

MAU-38/A BOMB RACK (TYP 2 PLACES)
PYLON TO STRUCTURE ATTACH POINTS (TYP 2 PLACES)
TO MANUAL RELEASE SYSTEM (TYP 2 PLACES)
FRONT
RELEASE SOLENOID
AFT PYLON
STRUT
SWAY-BRACES AND PADS (TYP 4 PLACES)
FORWARD PYLON
QUICK RELEASE PIN
AFT HOOK (TYP 2 PLACES)
SWAY-BRACE ADJUST SCREW (TYP 4 PLACES)
RELEASE SOLENOID
ARMING SOLENOIDS (TYP 2 PLACES)
(A)
FORWARD HOOK (TYP 2 PLACES)
BOMB RACK ELECTRICAL CONNECTOR
PYLON ATTACH POINTS (3 EACH END)
MAU-38A BOMB RACK
SWAY BRACE
AFT HOOK
PAD
FORWARD HOOK
SWAY BRACE ADJUST SCREW
(B)
AFT PYLON
MAU-38/A BOMB RACK (TYP 3 PLACES)
STRUT
SWAY-BRACES (TYP 6 PLACES)
FORWARD PYLON
STORE SENSING SWITCH
(C)
PYLON
MANUAL RELEASE MECHANISM
AERO 1/A ADAPTER
929472-101 BOMB RACK (MODIFIED AERO 65A1)
(D)
AERO 1/A ADAPTER
AO.411

Figure 5-1.–Bomb bay pylons. (A) Primary pylon; (B) alternate pylon; (C) 500-pound mine pylon; (D) 1,000/2,000-pound mine pylon.



NOTE: Dotted line indicates a 2,000-pound store.

VIEWS LOOKING FORWARD

AO.412

Figure 5-2.—Bomb bay configuration.

stores. The primary configuration consists of an Aero 15D combination bomb rack and rocket launcher. An optional wing launcher assembly may be used in place of the Aero 15D for carriage of mines and other specified weapons weighing in excess of 500 pounds. In addition, the optional launcher (presently identified only by a part number) is also used to suspend the Aero 5A-1/2 missile launcher when firing the Bullpup missile.

Loading is restricted to 611 pounds at stations 9 and 18 (extreme outboard station of each wing) and to 1,100 pounds at stations 10 and 17.

RELEASE AND CONTROL SYSTEM

The primary mode of operation for the armament/ordnance system is the automatic (on-line) mode. This system provides the flight crew with a means of computed delivery of most types of stores that may be carried. The automatic mode system is primarily the responsibility of the AT rating, but some components are maintained by the AO's. This brief description is to familiarize all AO's with the basic operation of the system.

The manual (off-line) mode is used for release and control of special weapons and missiles, and as a backup system for the on-line mode.

Automatic Mode

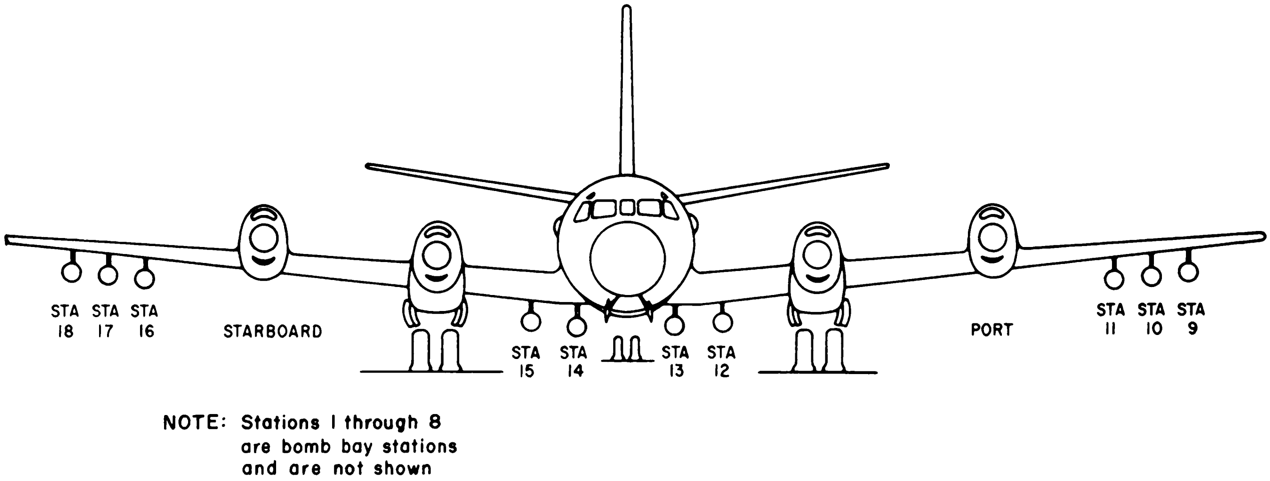
The primary mode of operation of the armament system is automatic (on-line), utilizing the computer, logic unit 2, pilots keyset and display, and TACOs tray and multipurpose display to control the armament system.

In the automatic mode, the armament system is designed to have the computer and other system components furnish the following functions:

1. Maintain an up-date inventory of all kill stores on the aircraft; provide a weapon inventory that can be called up for display on the TACOs auxiliary readout.

2. Determine the availability of a selected weapon and select the weapon station from which the weapon is to be released.

3. Energize the armament system relays at the proper time, in the proper sequence, and for



AO.410

Figure 5-3.–P-3 weapon stations.

the proper time duration to accomplish a weapon release under joint computer and operator control.

4. Instruct the operator (pilot or TACO), by cueing, to perform the required manual operations; that is, bomb bay door switch operation.

5. Present the operator with alternatives for which decisions are required, and furnish alerts to the operator to bring important developments to his attention.

6. Calculate and initiate fly-to-point weapon releases and intervals between releases for train (multiple) store releases; furnish release commands in response to the pilots or TACOs release commands.

7. Secure the armament system following each weapon release; that is, terminate arming outputs, check store-in-place status, update the inventory, and prepare the system for the next weapon selection.

STORE LOADING.–The weapons loaded on the aircraft must be recorded, by station number and type of weapon, into the computer memory. The stores inventory then can be displayed when desired by the TACO. Those stores which are carried, but are not to be released by computer control (in the automatic mode), should not be entered in the computer memory. The AGM-12B missile and torpedoes loaded on wing stations are in this category.

STORE SELECTIONS.–Following the manual weapon selection by the pilot or TACO, the computer locates one or more of the desired stores in memory. The computer then chooses the store to be released by the following priority:

1. The wing stations have priority over the bomb bay stations.

2. The outer wing stations have priority over inboard stations.

3. Wing stations must be selected so as to maintain nearly symmetrical loading.

4. The port wing has priority over the starboard wing, except for 3 above.

5. Bomb bay stations priority are; 8, 7, 6, 5, 4, 3, 2, 1.

Mines are the only weapon that can exercise the total priority gamut because they are the only weapons that are normally dropped from both wing and bomb bay stations. Although torpedoes can be carried on both the wing and bomb bay stations, they cannot be preset, deployed by parachute, or maintained in the required temperature controlled environment when carried on wing stations.

Within the aircraft armament circuity, the release of a store that is blocked (upper store when a store is immediately below) is prevented, regardless of what the computer might select. The purpose of the wing store priority as outlined is to maintain wing balance as stores are released. This priority assumes that weapons of a particular type have been loaded symmetrically; however, if an odd number is loaded, it is not important which wing carries the odd store.

WEAPON ARMING.–Weapon arming is initiated by the computer when the armament system is in the automatic mode. For weapons with no choice in arming, the arming is programmed in the operational program. Where there is a choice in arming, the arming mode is selected through the use of cueing on the TACOs multipurpose data display and the pilots display; the choice is made by decision button actuation. The computer initiates the actuation of the buffer relay (nose and/or tail arming, or bomb bay) which in turn energizes the wing armament system circuitry to the arming solenoids.

Special weapon arming is accomplished by using the T-414 AMAC system. The T-414 AMAC system provides continuous positive monitoring of the status (armed or safe) of the weapons.

Manual Mode

The manual (off-line) mode is considered to be an emergency backup system. In the manual mode, the armament system is independent of the data display and computer. No store inventory is available when using the manual mode, and the operator must keep a list of the load status at each station.

STATION SELECTION.—The TACO selects a weapon station in preparation for a release on either the WING or BOMB BAY STATION SELECT switch on the TACOs manual weapons control panel (the pilot has no conventional weapon selection capability).

If the station selected is in the bomb bay, the BOMB BAY light on the pilots armament control panel will come on. This light instructs the pilot to place the BOMB BAY switch to the OPEN position. The bomb bay light will remain on until the bomb bay doors are fully open. When the TACO returns the station selector to the OFF position, the BOMB BAY light on the pilots armament control panel will come ON to instruct him to place the BOMB BAY switch in the CLOSE position.

WEAPONS ARMING.—The arming switch on the TACOs manual weapons control provides the necessary selection for arming the type of store selected.

RELEASE MODE SELECTION.—The release mode selection switch on the TACOs manual weapon control panel provides selection of the type weapon and its mode of release. The choices are as follows:

1. Rocket ripple.
2. Flare.
3. Rack release (applicable for torpedoes, mines, depth charges, or any store for selective emergency release).

MASTER ARMING.—The MASTER ARM light comes on (located on the pilots armament control panel) as soon as the TACO makes a weapon selection. The light advises the pilot to place the MASTER ARM switch to the ON position. The pilots master arm switch gives the pilot final control over the release of a kill store from the aircraft. By switching the MASTER ARM switch to OFF, the pilot can override all other attempts to release a kill store.

TORPEDO PRESETTING.—When either a Mk 44 or a MK 46 torpedo is selected, the TACO then selects the bomb bay station and the torpedo type by positioning the torpedo presetter control panel switches. The TACO then sets the two rotary switches to the depth value desired and pushes the PRESET button. The PRESET button is held down until the indicator light goes off, indicating that presetting of the torpedo depth has been completed. The presetting operation requires approximately 3 seconds.

Jettison

The jettison function allows the pilot to release all of the kill stores on the aircraft quickly in an unarmed (safe) condition in an emergency. The guarded jettison switch on the pilots armament control panel initiates the jettison of all kill stores in an unarmed condition in approximately 20 seconds.

The jettison function can be initiated at any time regardless of whether a store selection is in progress or not. The jettison function takes precedence over any other armament system function in the manual or automatic mode. A separate guarded switch on the pilots console initiates the jettisoning for stores on the wing stations without jettisoning the bomb bay stations.

SEARCH STORES

The P-3C aircraft search store system provides the equipment and controls for selection and release of class A size sonobuoys from 48 unpressurized sonobuoy launch tubes (SLT) and 3 pressurized sonobuoy launch tubes (SLT). The 48 unpressurized SLT's are not accessible from inside the aircraft and must be loaded before takeoff. The 3 pressurized SLT's are accessible from inside the aircraft and may be reloaded while airborne. Stowage for 36 class A sonobuoys is provided in the aft cabin for use while airborne. An unpressurized free fall chute is also available for release of class A or class B size sonobuoys or other similar size search stores as may be authorized.

Release of sonobuoys is selective either by use of the automatic mode or manual mode.

OV-10A WEAPON SYSTEM

The OV-10A is a shore based aircraft designed for counterinsurgency operations. Two canted sponsons are mounted on the lower fuselage, providing four external store stations and housing for four 7.62-mm guns and their ammunition feed and supply systems. A fuselage centerline station also is provided for a store or external fuel tank. A single store station under each wing provides modification capability for carrying two AIM-9 Sidewinder missiles.

ARMAMENT EQUIPMENT

Two M60C 7.62-mm NATO machine guns are integrally installed in each sponson (fig. 5-4). The M60C is an electrically charged, gas-operated weapon which is adapted from the M60 NATO automatic rifle. Each pair of guns (left and right) may be charged separately on the ground or in flight. The ammunition cans (one for each gun) each contains 500 rounds of either or a combination of tracer, ball, or armor piercing ammunition.

In addition to the M60C, the OV-10A can also utilize the Mk 4 Mod 0 gun pod. The Mk 4 gun pod houses a Mk 11, gas/recoil-operated, twin barrel 20-mm gun. The Mk 11 gun fires the Mk 100 series ammunition from an eight chamber cylinder. The ammunition is belted with Mk 6 Mods 4, 5, or 6 links. The spent casings and links are ejected overboard near the rear of the pod. The pod is self-powered and electrically

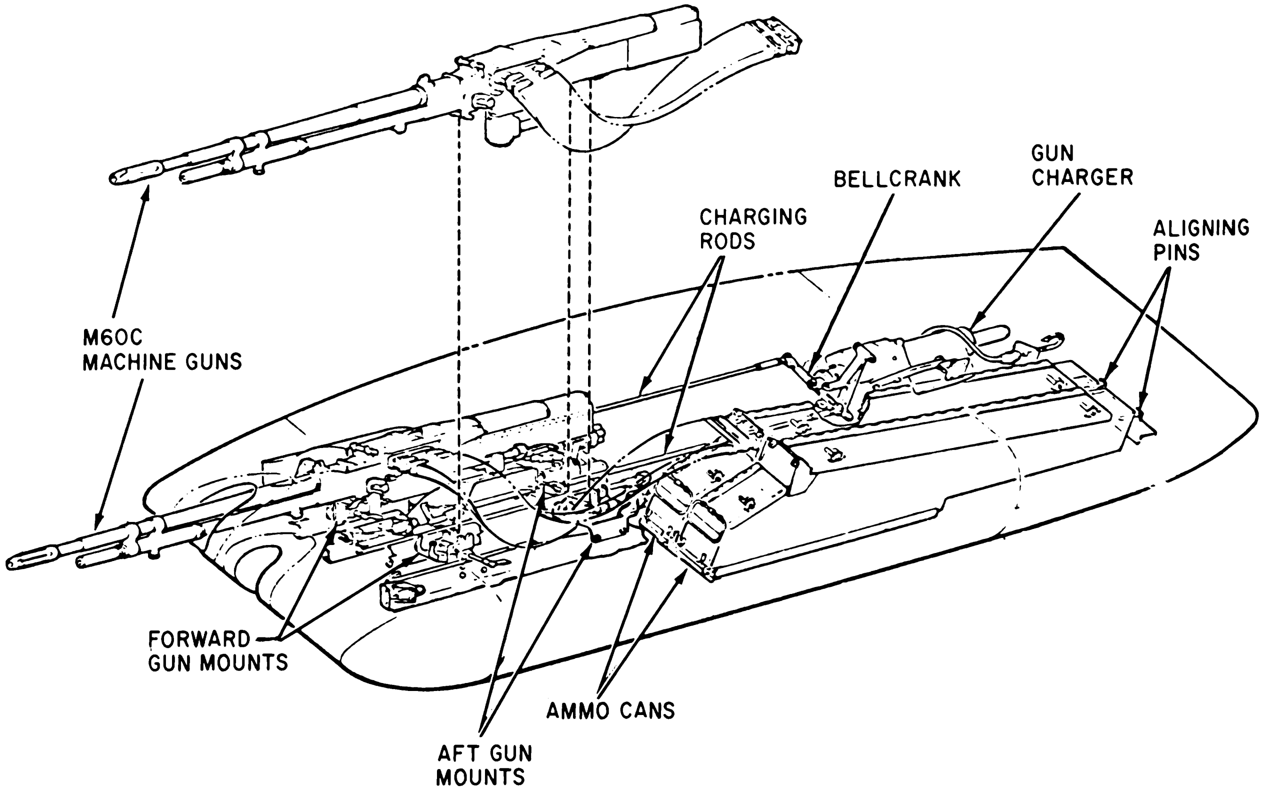


Figure 5-4.—OV-10A M60C minigun LH installation.

charged and cleared. The gun has a selective rate of fire, which may be preset at either 700 or 4,000 rounds per minute. The gun charging and clearing system is composed of a pneumatic pressure storage bottle, an accumulator, a valve, and interconnecting lines. Prior to flight, the pneumatic stowage bottle is charged to 3,200 (±200) psig with air or nitrogen.

When firing the Mk 11 gun, short bursts should be used to prevent overheating. A total of 15 minutes should be allowed during fire-out of a fully loaded pod (750 rounds). Burst lengths up to 2 seconds is recommended, with 3 minutes cooling time between firings. Maximum burst time is 6 seconds.

The Aero 65A1 and Aero 65A1/B1 bomb racks are utilized on the sponsons for carrying and releasing almost all types of bombs, rocket launchers, and other types of weapons that can be suspended with 14- or 30-inch suspension.

Wing mounted pylons can be installed on each side of the sponsons, which will permit installation of the LAU-7A launcher which in turn can suspend one AIM-9B/D air-to-air missile or one LAU-33A/A rocket launcher for firing two Zuni rockets each.

HELICOPTER ARMAMENT SYSTEMS

Helicopters have been used primarily in antisubmarine warfare in previous years, are also now being utilized as gunships in support of river patrol boats, for rescuing downed pilots, and for other missions that require a quick response time. Operating from advanced areas, the gunships are equipped with bomb shackles that permits them to carry a large variety of weapons. Some are also equipped with the TAT-102C minigun mounted in turrets attached to the bomb shackles (such as the HH-3A).

AO's assigned duty within a helicopter squadron can expect to work with aerial torpedoes, some types of missiles, pyrotechnics, and sonobuoys. The bomb racks/shackles and other armament equipment with which he will be associated can be found on other types of naval aircraft and should not present a problem to a knowledgeable aviation ordnanceman.

CHAPTER 6

GUIDED MISSILES

A guided missile is defined as an unmanned vehicle, designed as a weapon, which travels above the earth's surface along a course or trajectory that can be altered by a mechanism within the missile itself; this vehicle destroys itself in carrying out its mission.

This definition is broad enough to include many possible variations in design and tactical applications. The operation of guided missiles involves the fields of aerodynamics, radar, infrared techniques, propellants, radio-wave propagation, telemetry, automatic control, and specialized ordnance applications. Effective use of the guided missile as a part of a weapon system requires qualified personnel for its handling and use.

Guided missiles have been developed to overcome the limitations of conventional weapons and offer the following advantages:

1. Increased range from the point of release to the target.
2. Decreased susceptibility to countermeasures.
3. Increased destructive effect resulting from improved accuracy and a larger destructive load.

Although missiles have been operational for several years, research on current missiles as well as missiles involving new theories is continuously producing changes in the missile field. Therefore, missiles that are operational today may be obsolete tomorrow. The missiles discussed in this chapter are presently current. Although changes may be made in these missiles, they contain most of the basic components of any air-launched missile system.

One of the essential characteristics of the guided missile is the use of electromechanical systems for carrying out the actions of guidance and control—the processes that are performed by the pilot in conventional aircraft. By automatic action, the missile then becomes a projectile which is able to correct its path as it flies toward the target; and by compensating for inaccuracies in aiming and for evasive motions of the victim, its probability of striking and destroying the enemy object is greatly increased.

The four basic processes in missile guidance and control are tracking, computing, directing, and steering. In flight, the vehicle is steered by means of movable wings, by movable or controlled thrust jets, or by other kinds of devices which are actuated by the control system, or autopilot. Most control systems contain sensing instruments, such as gyroscopes and accelerometers, which detect deviations in the attitude and direction of the missile, and also servomechanisms, which adjust the airfoil surfaces. By these means, the missile is maintained in stable flight. That is the axes of pitch, yaw, and usually of roll, are properly inclined to some reference plane, such as the surface of the earth or an arbitrary plane in free space.

Information on the operation of gyros and accelerometers can be found in chapter 5 of Synchro, Servo and Gyro Fundamentals, NavPers 10105.

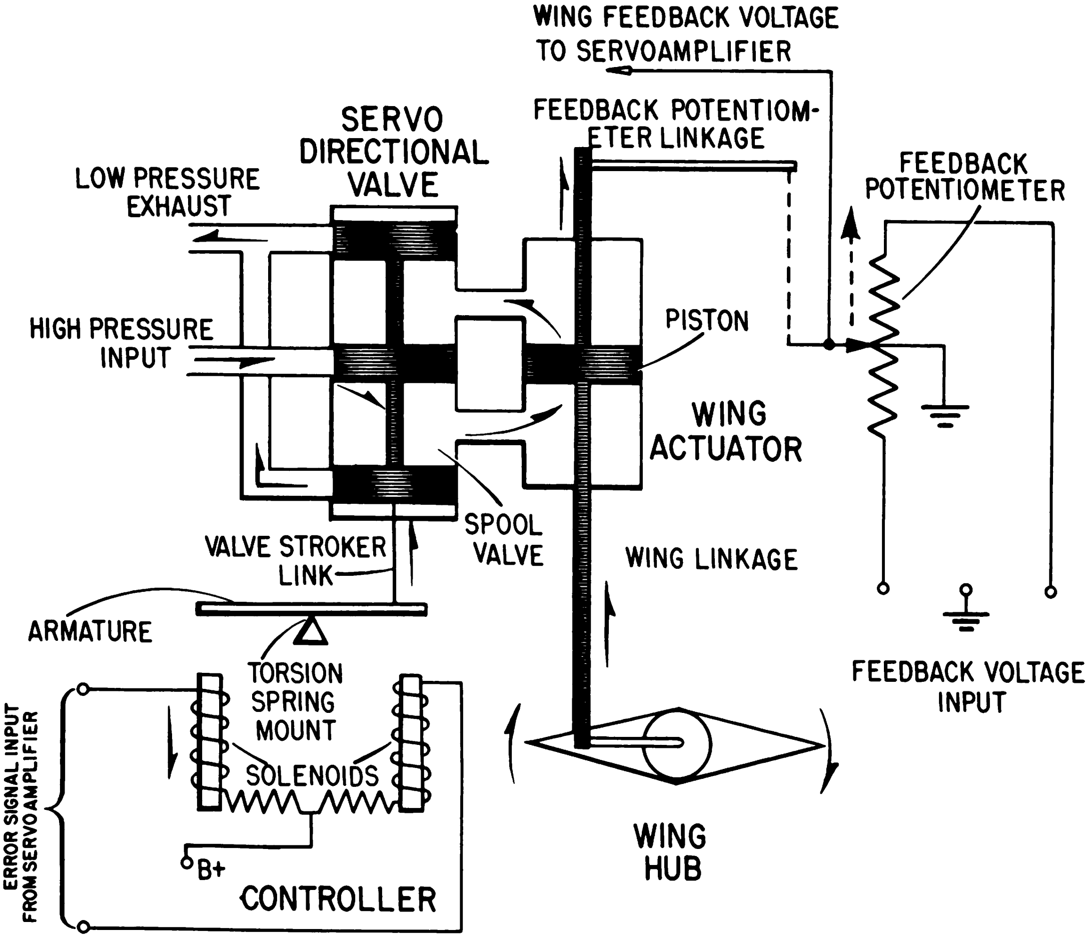
All missiles must carry sources of primary energy and also mechanisms that convert this energy into large amounts of mechanical output power. In most missiles, these requirements are met by the use of fluid equipment, or devices employing liquids and gases under high pressures. This equipment is of two kinds: hydraulic units, which operate by means of liquids; and pneumatic components that release and control the energy stored in compressed gases, such as air or nitrogen.

Hydraulic and pneumatic systems are employed in several ways in missile applications. They provide the major components of the wing servosystem, that section of the total control system that steers the weapon in flight by adjusting the wings, or control surfaces. They also serve as prime movers for electric generators carried in the vehicle. In addition, fluid equipment is required in most missile test sets to supply pressurized gases and liquids for operating the missile-borne equipment during tests and checks made prior to launching.

The essential features of both types of wing-actuator units are shown in figures 6-1 and 6-2. Both types release large quantities of energy stored in fluid systems to operate the missile wings during flight. Both units are controlled by electrical signals supplied by the guidance-control systems.

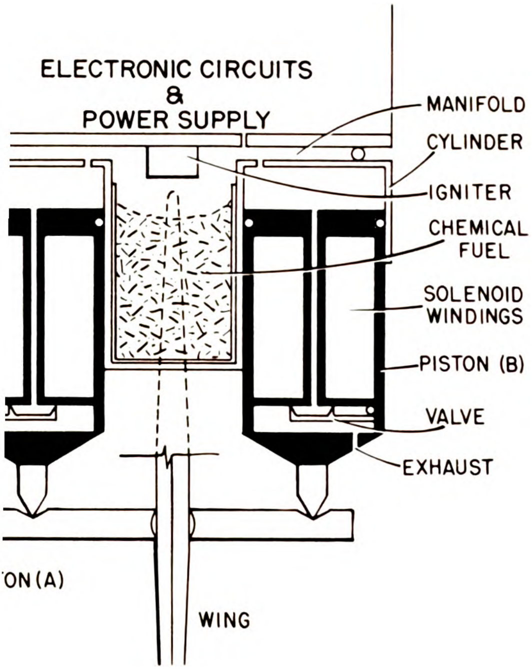
The wing actuator (fig. 6-1) converts the energy of the hydraulic fluid into motion of the enclosed piston. The piston, in turn, operates the movable wing through a mechanical linkage mounted within the wing hub.

Figure 6-2 is a simplified schematic representing a gas-actuated unit of the type used in missiles containing all-pneumatic wing servo-systems. At missile launch, the chemical fuel is fired by the igniter; and the hot gas generated by the burning fuel enters the manifold, which conducts it to the two actuator cylinders.



AO.527

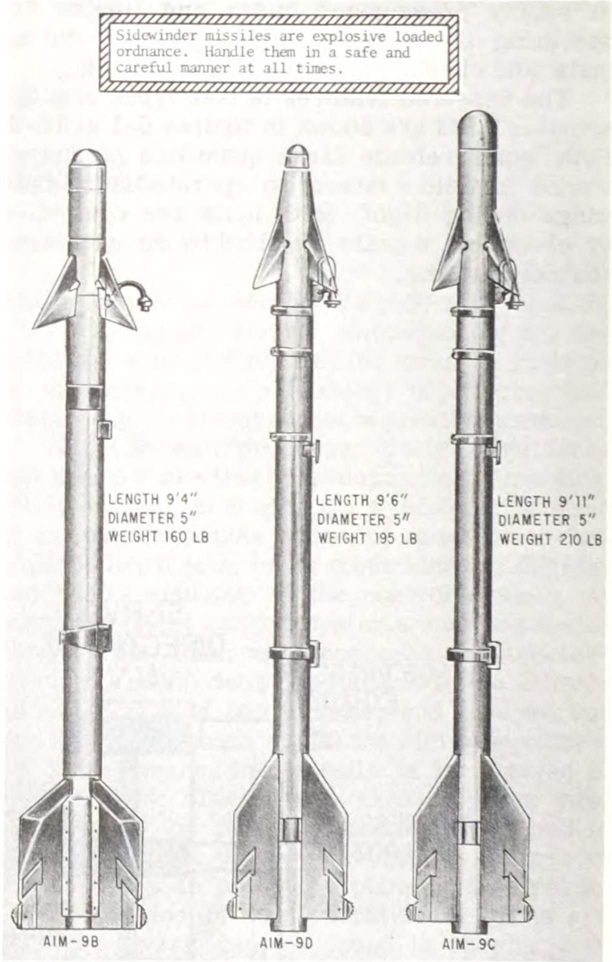
Figure 6-1.—Servo valve with mechanical control and wing-actuator unit.



AO.528
6-2.—Gas-actuated wing-control unit.

SIDEWINDER

Sidewinder guided missile is a super-
ir-to-air homing weapon that employs
n infrared (IR) or a radar (RF) guidance
. There are several variations of the
, all of which are 5 inches in body di-
but which differ in length between 9 and
. (See fig. 6-3.) The overall weapon
between 150 and 200 pounds: The Side-
is propelled by a solid propellent rocket
and contains a high explosive warhead.
rent models in fleet usage are the AIM-
the AIM-9D. The AIM-9C is a semi-
adar guided weapon. The AIM-9D utilizes
roved infrared homing guidance system.
M-9G is still another improved version
riginal AIM-9B. The AIM-9G is equipped
idewinder expanded acquisition mode
that allows the missile's IR seeker to
ead on a target not directly ahead of the
aircraft at the time of launch. Another
ement in the family of Sidewinders is
ed for fleet introduction in 1971 and will be known as the AIM-9H. The AIM-9H is a solid-state electronics version of the AIM-9G. The improved electronics package provides increased reliability and maintainability over the 9D and 9G models.


Sidewinder missiles are explosive loaded ordnance. Handle them in a safe and careful manner at all times.

AO.529
Figure 6-3.—The Sidewinder family.

The latest development in the Sidewinder family, AIM-9L, will be a joint-service missile developed under Navy management. It is expected to serve as an interim air-to-air weapon until the Agile missile is ready for fleet use. The AIM-9L features an improved seeker element, improved acquisition, increased firing zone, and more maneuverability due to an improved canard design, more active optical fuze, and an improved warhead.

The Sidewinder is launched from a rail type launcher attached to a high-speed aircraft. The missile is made up of the following major components—guidance and control section, fuzes, warhead, rocket motor, and wing assembly. Figure 6-3 shows the Sidewinder family of missiles.

GUIDANCE

The Sidewinder guidance components can be grouped into two broad classifications—the Sidewinder AIM-9B and the Sidewinder AIM-9C and 9D. The guidance and control components used with the AIM-9B are known as "sections," while those for the AIM-9C/D missile are called "groups." (See fig. 6-4.)

The guidance control section for the AIM-9B is the Mk 1 (Mods 0 through 15), which is easily distinguishable by its transparent dome. The Mk 1 section contains the following basic components.

1. A gas-generating propellent grain that provides missile control power during flight.
2. An infrared optical system that tracks a target.
3. Electronic devices that interpret signals from the target.
4. A control servo that moves the fins to guide the missile.

The Mk 1 (Mods 6-15) contains a small amount of mercury-thallium. This is a poison which may be released if the nose is cracked.

The guidance control group for the AIM-9D which also employs an infrared homing seeker is the Mk 18. This group is readily identifiable from the Mk 1 in that it utilizes a translucent dome rather than a transparent dome. High sensitivity to heat is provided by the use of liquid nitrogen or air to cool the IR detector before the missile is fired. The coolant tank is installed in the missile launcher. This guidance and control group also contains a small amount of mercury-thallium.

The AIM-9C utilizes the Mk 12 guidance and control group which is a radar seeking device. It is characterized by a hemispherical nose made of a ceramic material. It is longer than the IR guidance and control group.

FUZES

Sidewinder missiles are fuzed to explode either upon contact or upon sensing proximity to a target. (See fig. 6-5.) Sidewinder AIM-9B has two fuzes, a contact fuze and an influence fuze. Sidewinder AIM-9C/D has a single fuze made up of two subcomponents; a target detecting device (TDD), either IR or RF; and a safety arming (S-A) device.

Contact Fuze Mk 304

This fuze (fig. 6-5) is a backup system for the proximity fuze system and it functions when the missile strikes the target. The fuze is assembled to the guidance and control section and extends into the forward fuze cavity of the warhead. It has a detonator, a lead-in, and a booster.

Fuzes, Mk 322 and Mk 323

These fuzes use one of two types of target detecting devices. Mk 322 is a radiofrequency device and Mk 323 is an infrared device. The target detecting device is located between the guidance and control group and the warhead.

A Mk 13 safety arming device is used with the target detecting device. Its purpose is to prevent detonation of the warhead during assembly and handling (by maintaining breaks in the explosive train and in the electrical circuitry), and it permits the missile to arm only after it has traveled a safe distance after launch. The S-A device connects to the TDD and fits into a cavity in the warhead. It explodes a booster that is integral to the warhead.

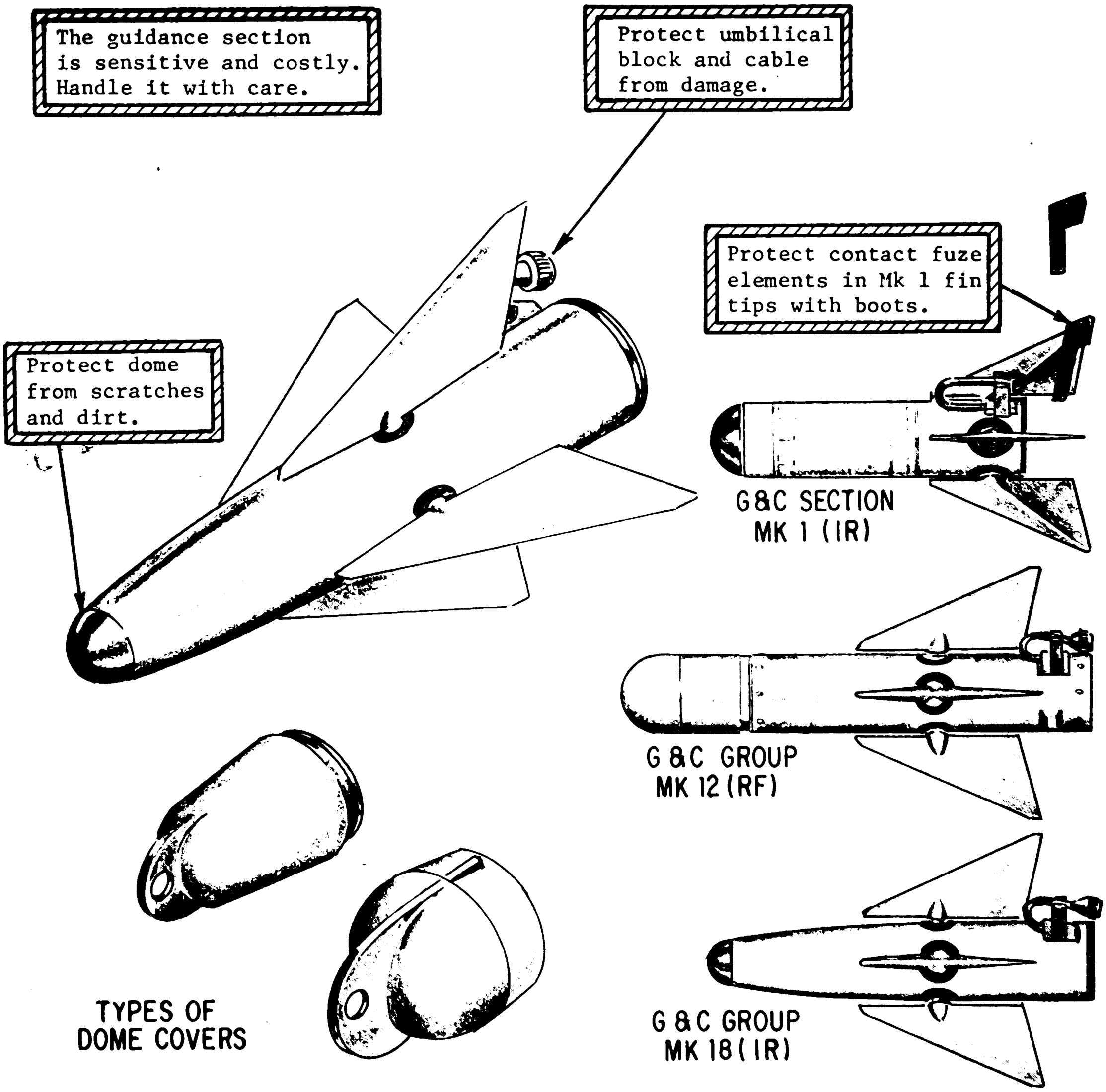
Influence Fuze Mk 303

This fuze (Mods 2 and 3) is a short cylindrical device (fig. 6-5) that is placed between the warhead and rocket motor. It consists of a battery, target sensing device, and a safety arming device. The fuze is used with the Mk 34 booster which extends into the warhead. Windows on the fuze body, associated with target detection, are covered by a plastic strip.

This fuze is used in Sidewinder AIM-9B to prevent the escape of gas through a slot in the threads of this influence fuze; it must be assembled with a rubber slot filler and used in conjunction with a proper O-ring.

WARHEADS

Warheads are explosive loaded devices, cylindrical in external shape. (See fig. 6-6.) When



The guidance section is sensitive and costly. Handle it with care.

Protect umbilical block and cable from damage.

Protect contact fuze elements in Mk 1 fin tips with boots.

Protect dome from scratches and dirt.

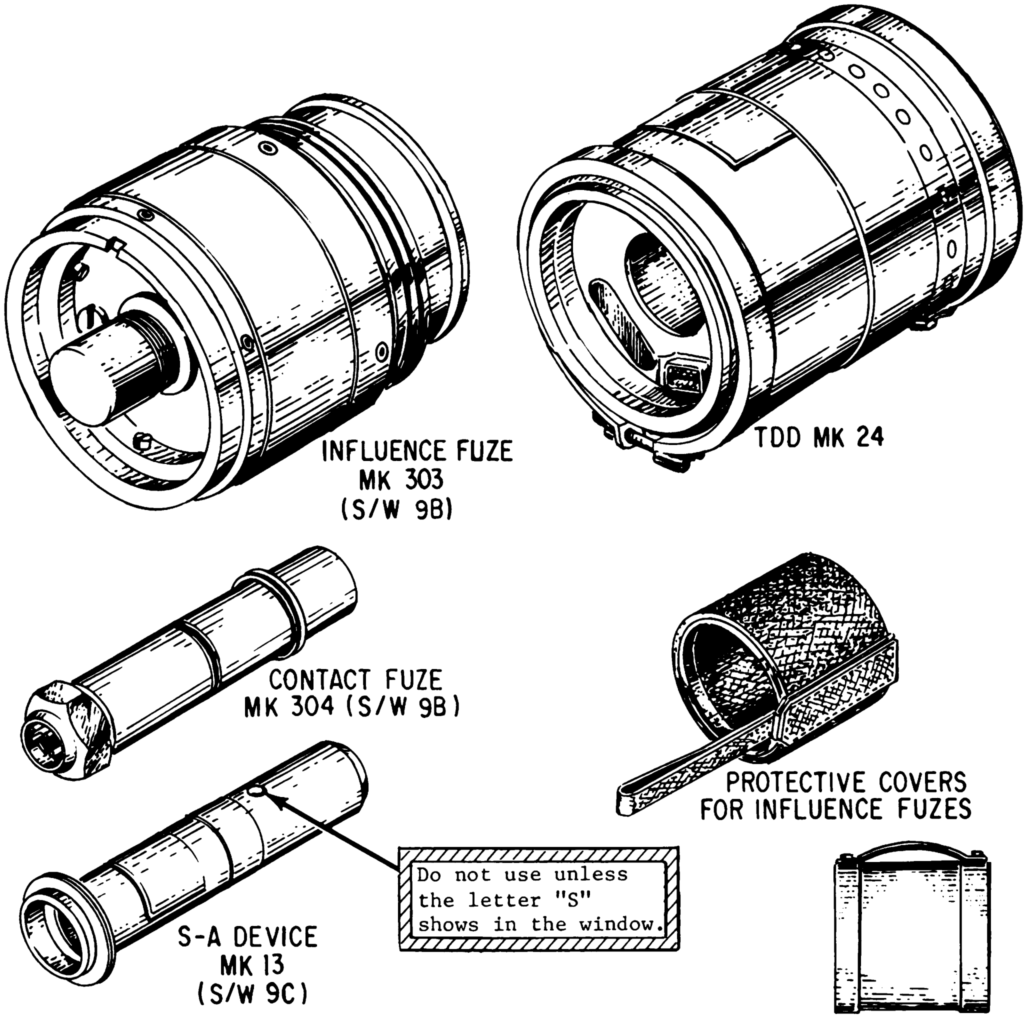
AO.530

Figure 6-4.—Guidance and control sections or groups.

assembled, they contain a safety arming device and a high explosive booster.

The safety arming device is fitted with two electric detonators and acts to prevent a missile from arming until it is a safe distance from the launching aircraft. Proper electrical signals from the guidance and control section explode the safety arming device and the warhead. Warheads are sensitive to shock and must be handled carefully.

The Mk 8 warhead is a service item designed to take a contact fuze on one end and an influence fuze on the other. It does not contain an integral booster (these being assembled with the fuzes). The Mk 2 exercise



Do not use unless the letter "S" shows in the window.

AO.531

Figure 6-5.—Sidewinder fuzes.

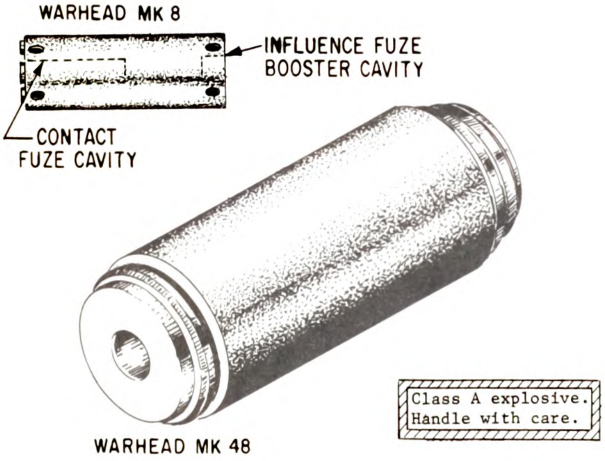
head is similar to the Mk 8, but has a pyrotechnic filler instead of high explosives.

The Mk 48 warhead is a service item having an integral booster. It is designed to be fuzed at one end only.

ROCKET MOTOR

The rocket motors (fig. 6-7) employed on the Sidewinder missiles are of the solid propellent type. These rockets are very delicate and should be handled with the utmost care and attention. Careless handling can crack the grain and this will lead to faulty operation. A cracked propellant may not only give an unpredictable flight performance, it may blow up on ignition. Cracked grains are to be suspected in any motor that is dropped. Temperatures of either extreme will also affect the functioning of the rocket motor.

A nonpropulsion attachement is provided for Sidewinder AIM-9B motors and is installed over the nozzle end of a motor that has been assembled to an influence fuze. It is to be removed just prior to the installation of the missile on the launcher.


WARHEAD MK 8
INFLUENCE FUZE BOOSTER CAVITY
CONTACT FUZE CAVITY
Class A explosive. Handle with care.
WARHEAD MK 48

AO.532

Figure 6-6.—Sidewinder warheads.

TESTS AND TEST EQUIPMENT

For AO's attached to operating squadrons or carriers, the testing of Sidewinder missiles is a relatively simple job when compared to tests that must be performed on other types of missiles. The Sidewinder, by nature of its simple design, has a high degree of reliability and performance, but requires little more testing than an aircraft rocket.

Testing by squadron AO's is limited to a GO or NO-GO test of the launcher and the aircraft wiring. However, the missile must be thoroughly inspected before and after it is suspended on the launcher. The launcher and aircraft wiring is tested, with the aid of the Test Set, Guided Missile Launcher AN/ASM-11 or AN/ASM-20B.

NOTE: The LAU-7/A launcher can be used to fire all versions of the Sidewinder missile while the AERO 3A launcher is limited to firing the AIM-9B missile only.

Guided Missile Launcher Test Set AN/ASM-11

The AN/ASM-11 test set (fig. 6-8) provides a GO, and NO-GO determination that the power supplied to the AIM-9B missile (both standby and firing) is within voltage tolerances, that the missile firing sequence is operating satisfactorily, and that firing circuits are safe. In addition, it may be used to show that the aircraft launcher circuits are operational and that the jettison circuits function properly.

A special purpose electrical cable assembly is furnished with the test set and is used to provide the required connections between the test set and the missile launcher or aircraft circuit being tested. An adapter connector is also furnished and adapts the test set cable assembly to the aircraft circuit when the launcher is removed from the aircraft circuit.

For a complete description of the operation and use of the AN/ASM-11 tester (plus maintenance and calibration of the tester), refer to the Operation and Maintenance Instruction Manual, NavAir 16-30ASM11-1 (or latest edition), or other appropriate publications. (NOTE: This is a launcher tester and not a Sidewinder missile tester.)

Guided Missile Launcher Test Set AN/ASM-20B

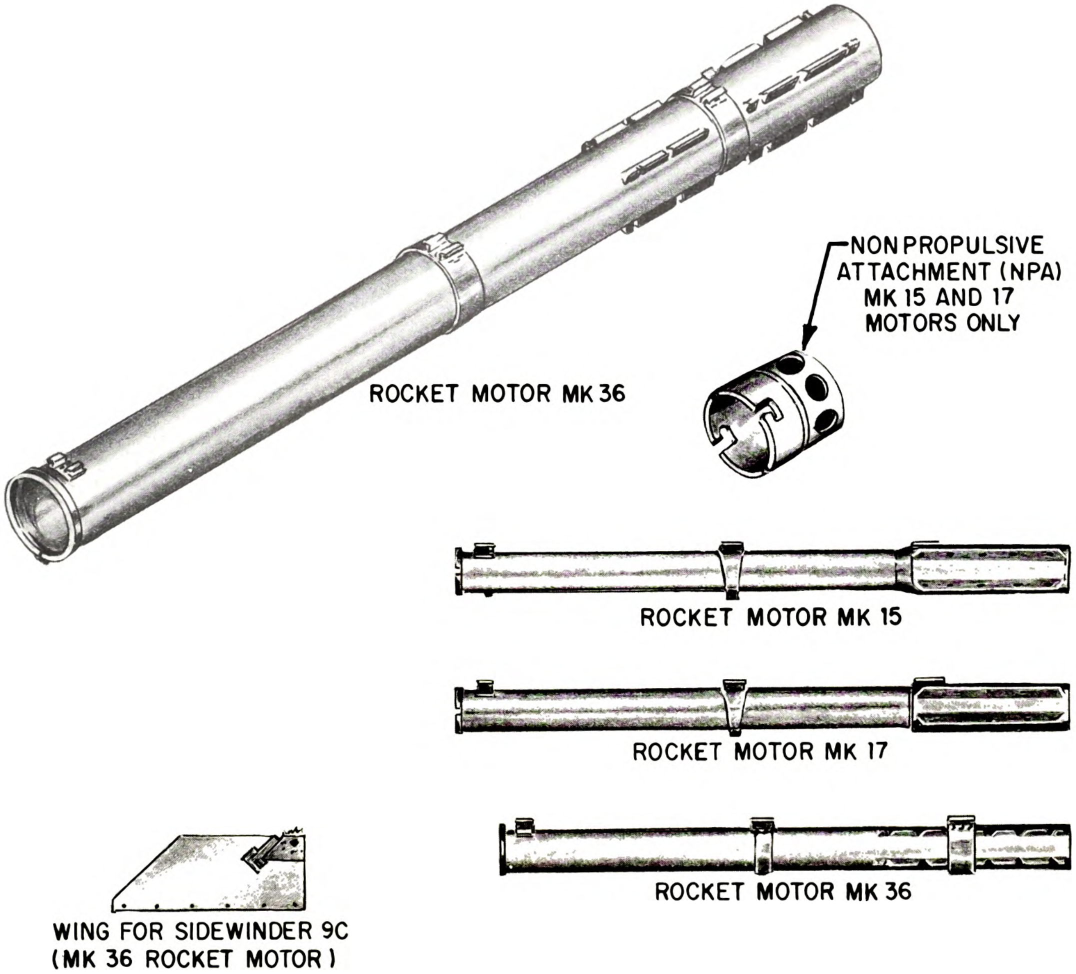
The AN/ASM-20B test set, as shown in figure 6-9 and described in NavAir 16-30ASM20-2, is used to test aircraft and launcher circuitry for all current fleet models of the Sidewinder missile. This test set is the same as the AN/ASM-20 except that Support Equipment Change No. 977A was incorporated.

Operating instructions for testing the aircraft and launcher circuitry are contained in the Conventional Weapon Check List for the aircraft to be tested.

The purpose of Guided Missile Launcher Test Set AN/ASM-20B is to check the electrical circuitry contained in the Launcher Aero 3A (or equivalent) and the Guided Missile Launcher LAU-7/A, used to fire Sidewinder missiles, and to check the aircraft circuitry associated with these launchers. It does not test the missile circuitry, but does provide a GO/NO-GO indication of the launcher and aircraft circuits being tested. The AN/ASM-20B is electromagnetically shielded, which eliminates erratic measurements when used on the flight deck.

The test set may be used to indicate whether or not aircraft-supplied inputs to the launcher and voltages to the missile are within acceptable limits.

Each of the three Sidewinder missiles has certain unique input requirements from the launcher and supplies certain unique signals and indications to the launcher and aircraft. The test set simulates the missile by providing the signals and indicators for the selected type


ROCKET MOTOR MK 36
NON PROPULSIVE ATTACHMENT (NPA) MK 15 AND 17 MOTORS ONLY
ROCKET MOTOR MK 15
ROCKET MOTOR MK 17
WING FOR SIDEWINDER 9C (MK 36 ROCKET MOTOR)
ROCKET MOTOR MK 36

AO.533

Figure 6-7.—Sidewinder motors.

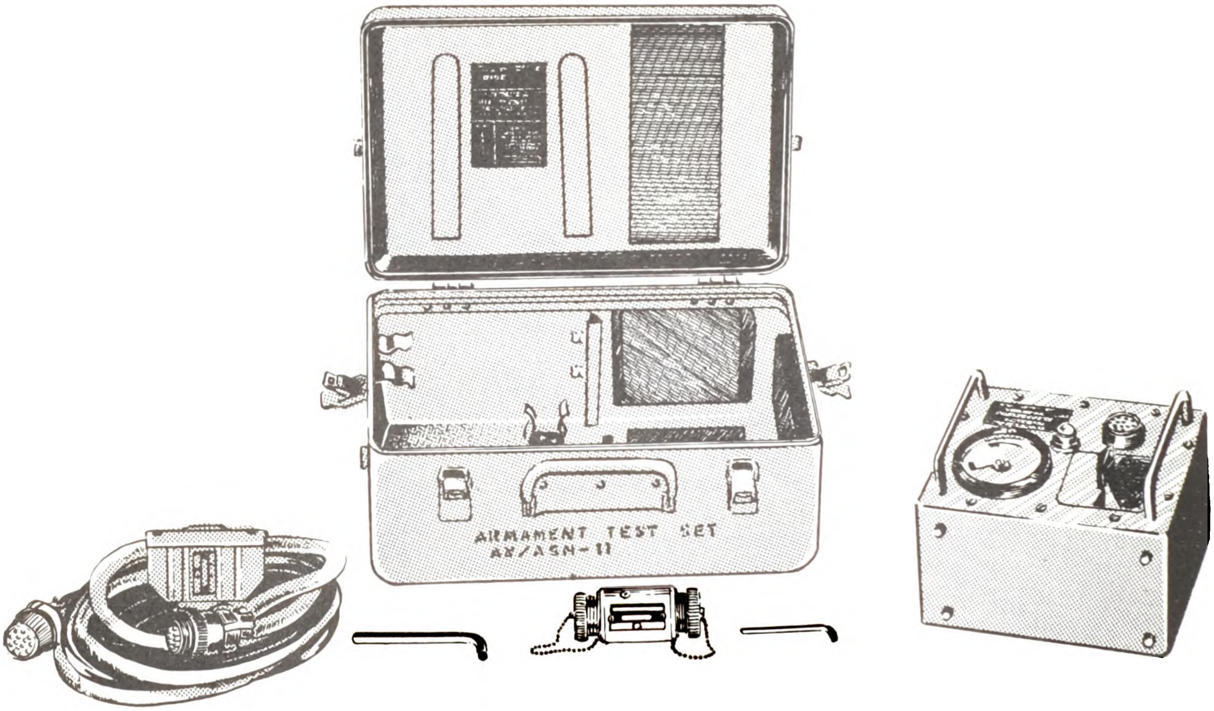
of Sidewinder and tests the missile inputs from the launcher to be sure they are appropriate for the type selected. A gas pressure tester is included to indicate that the gas system for the AIM-9D (IR) Sidewinder missile is properly pressurized.

The test set comes with all adapters and connectors required to perform the tests described above.

PASSIVE FILTRATION AND CHARGING UNIT, MODEL 1012A

The Passive Filtration and Charging Unit, Model 1012A (fig. 6-10) is used to charge the coolant tanks of the LAU-7/A missile launcher. The unit is maintained and operated by the GM division aboard carriers.

When a launcher coolant tank requires recharging, the coolant tank is removed from the



AO.534

Figure 6-8.—Test Set, Guided Missile Launcher AN/ASM-11.

launcher by squadron ordnancemen and taken to the GM division for filling. NavAir 19-25D-20 provides detailed information on the passive filtration unit.

PREFLIGHT INSPECTION

After the missile has been properly positioned on the launcher and the umbilical plugs properly installed, power is applied to the missile for a preflight check of the complete system. This is accomplished by the pilot and an ordnanceman working together just prior to takeoff.

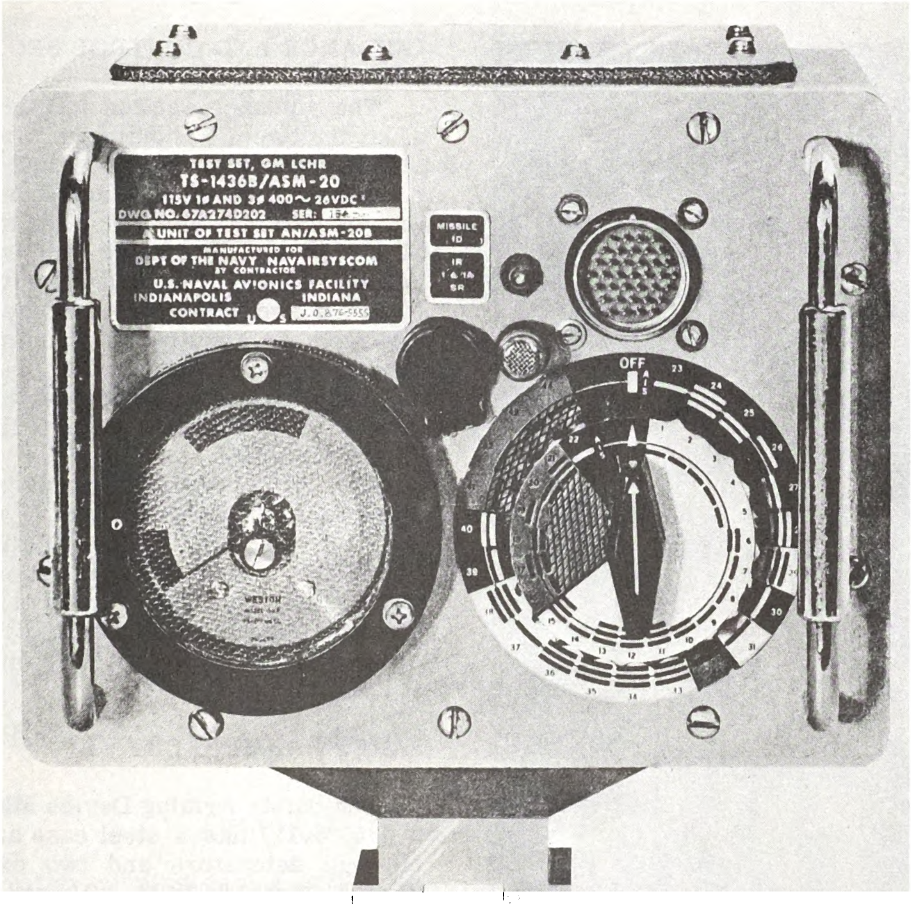
The ordnanceman is stationed from 6 to 10 feet to the front of the missile but not directly in the missile's path. Upon receiving a signal from the pilot, the AO moves a lighted flashlight up and down and then back and forth across the front of the missile. If the missile is functioning properly, the pilot should hear a 400-Hz tone in his headset with each pass of the flashlight in front of the missile.

If the pilot does not hear the 400-Hz tone and the AO is positive that the missile is installed correctly, the AO should take a heavy piece of steel, such as a crescent wrench, and move it around the nose cone of the missile. Normally, this will induce the gyro to spin.

SPARROW III

The second air-to-air missile type presently in Navy use is Sparrow, another system that has been in service for a good many years. The current design is the third generation Sparrow III which, as AIM-7C, first flew in 1953 and owes some of its features to earlier Sparrow types dating back to 1946.

Sparrow III is now represented in the Navy inventory by three models—AIM-7D, AIM-7E, and AIM-7E2. AIM-7D is now used as a training missile, while the other two versions are our basic fleet air defense missiles. Sparrow III features four cruciform wing and tail surfaces



AO.535

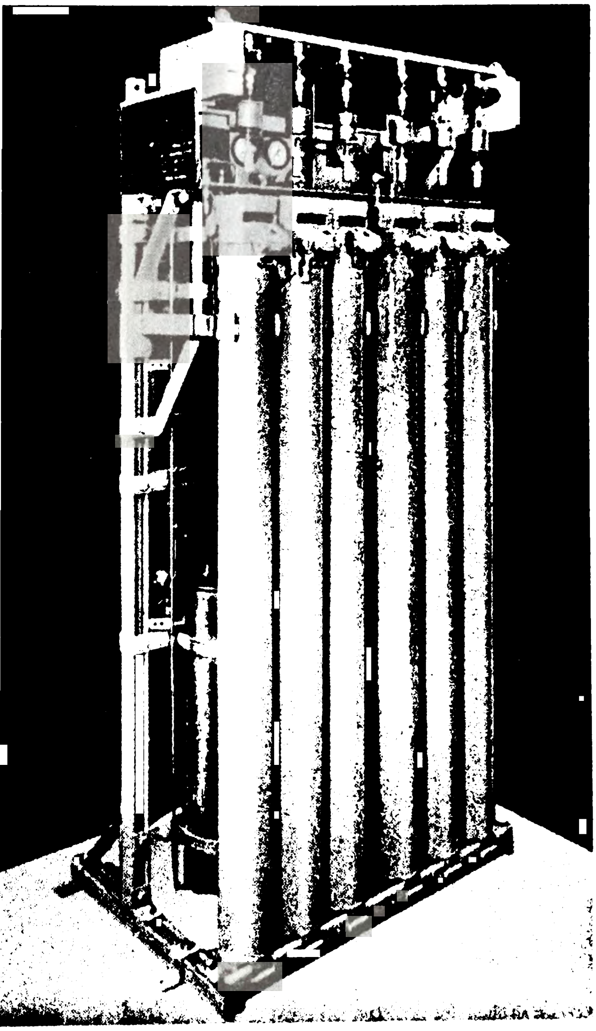
Figure 6-9.—Guided Missile Launcher Test Set AN/ASM-20.

mounted on a 12-foot cylindrical body with an ogival radome nose. The wings have a span of 40 inches and provide both lift and maneuvering forces. The wings are moved in pairs by a hydraulically operated servosystem. Fixed tail fins give in-flight stability. The missile is composed of six basic assemblies: a radar target seeker in the nose, autopilot to translate target data inputs to control signal outputs, wing hub with control mechanisms for the wings, a conventional explosive warhead detonated by a proximity fuse, a solid propellant rocket motor and fixed stabilizer fins.

The launching aircraft's radar performs search, acquisition, tracking and illumination of the target. Data is fed to the guidance section of Sparrow prior to launch, to prepare it for target acquisition. After firing the Mach 3+ missile, the pilot maintains his general heading to provide target illumination while Sparrow's proportional navigation system keeps it on course to intercept.

AIM-7E provides increased performance capabilities over the 7D version and, as a result of lessons learned in Southeast Asia, a more maneuverable variation, the AIM-7E2, has been developed for close-in air combat. Sparrow missiles are currently in use on Navy and Marine F-4B's and F-4J's as well as USAF and certain foreign F-4 models.

The latest version of Sparrow, AIM-7F, is planned to replace the AIM-7E/7E2 for use with the Navy's newest fighter, the F-14. AIM-7F is now in development and will have greater range due to its larger solid propellent motor with two thrust levels—boost and sustain. It will retain the excellent short-range characteristics



AO.536

Figure 6-10.—Passive Filtration and Charging Unit, Model 1012A.

f AIM-7E2 and will be compatible with aircraft ow using the E models. The F model is designed vith all solid-state electronic circuits which ermit more volume for other major missile ections, such as warhead and motor. Other eatures will include "snap start" capability iving improved reliability and pulse Doppler in ddition to continuous wave radar capabilities. igure 6-11 depicts a typical Sparrow III missile.

The major components of the Sparrow III are s follows: Guidance and control section, safety rming device, warhead, and the rocket motor. These components are discussed briefly in the following paragraphs.

GUIDANCE AND CONTROL SECTION

The guidance section for the Sparrow III is a semiactive CW homing unit and has a 360° attack capability. It has either a plastic or a ceramic radome that contains a movable sensing (target seeking) element. The sensing element is moved by a hydraulic unit which contains a gas powered unit actuated by two squibs. The guidance section or the radome alone may be replaced, if required, by a similar unit as a normal assembly operation, but further disassembly by fleet operational units is not allowed. Temperature storage limits for these sections are -65° and 165° F.

The control section contains an autopilot and a hydraulic wing control unit. Later versions of the missile employ an electric power unit powered by a solid fuel gas generator ignited by two squibs. The entire control section may be replaced as a normal assembly operation, but further disassembly by fleet operational units is not allowed.

SAFETY ARMING DEVICE

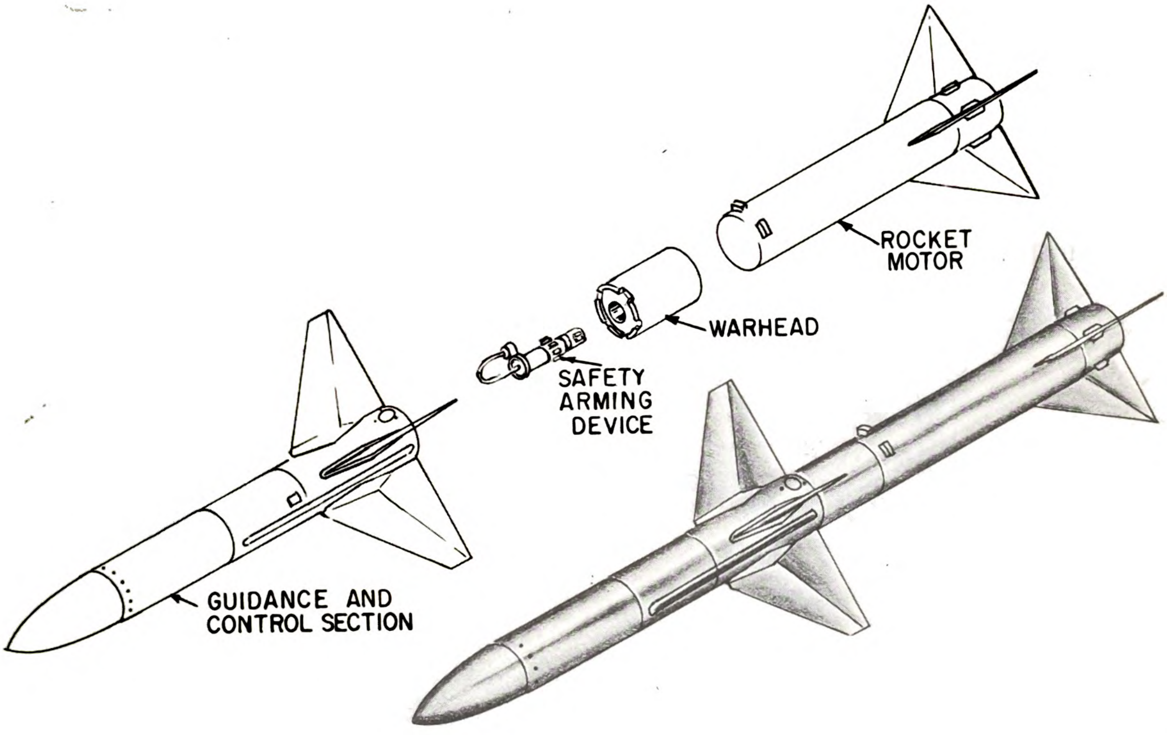
The Safety Arming Device Mk 5 Mod 0, 1, or 2 (fig. 6-12) has a steel case and contains two electric detonators and two explosive leads. The booster, Mk 38 Mod 0, used with the safety arming device, contains a small tetryl charge.

After launch and during missile acceleration, the rearward movement of a setback weight within the safety arming device releases an escapement mechanism. As the missile decelerates after motor burnout, the setback weight in the safety arming device moves forward under spring pressure to lock the rotors in the armed position and closes a final arming switch. The safety arming device is then ready to fire.

The Mk 4 Mod 0 exercise warhead used on Sparrow practice rounds will usually contain a safety arming device, a booster, and two pyrotechnic flash signals. Tactical service and exercise warheads must be stored in controlled areas with temperatures between limits of -65°F and 115°F.

WARHEAD

The warhead for the Sparrow missile is cylindrical in external shape. When assembled,



AO.537

Figure 6-11.—Typical Sparrow III missile.

it contains a safety arming device with a high explosive booster and electronic firing switches. Electrical signals from the guidance and control section explode the safety arming device and the warhead. Warheads are sensitive to shock and must be handled carefully.

ROCKET MOTORS

The Sparrow III rocket motor (fig. 6-13) contains a tubular solid propellent grain in a steel case, with a nozzle (tail cone) at the after end and an igniter assembly at the forward end. Launch hooks are located at the igniter end. Between the launch hooks is a plug for attaching the motor fire connector from the aircraft launcher.

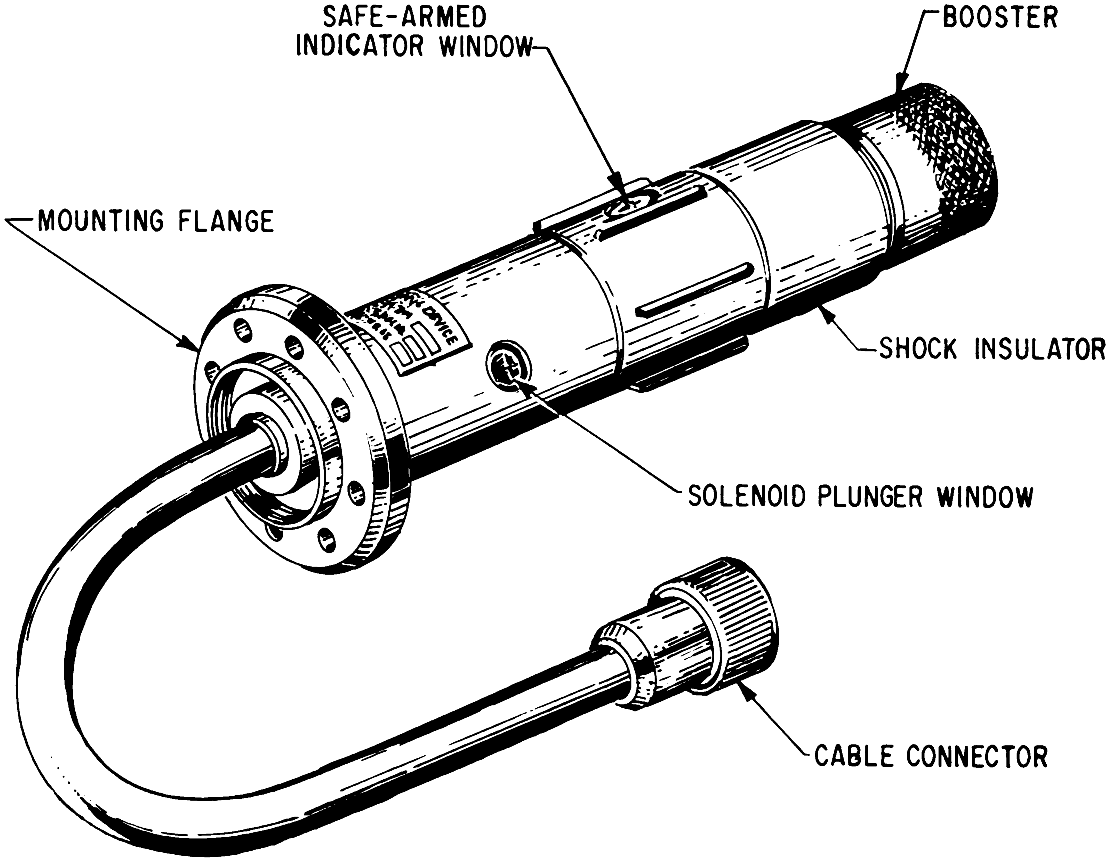
The Sparrow III utilizes the Mk 6, Mk 38, or Mk 52 rocket motor. The Mk 258 igniter is used with the Mk 6, the Mk 265 igniter is used with the Mk 38, and the Mk 274 is used with the Mk 52 rocket motor. Mk 6 and Mk 38 motors are very similar in appearance except that the Mk 6 motor requires assembly of an aft fin support (fig. 6-13), while the Mk 38 motor has a fixed boattail for support of the tail fins. Rocket motors should also be stored in a controlled temperature environment.

TESTS AND TEST EQUIPMENT

Operational testing of the Sparrow III missile is usually confined to the guidance and control section. The AN/DSM-32 or AN/DPM-7A guided missile test sets are used to perform these tests. Tests are conducted upon receipt of the components and at specified times thereafter.

Due to the complexity of these two testers, senior AO's should make every effort to observe newly formed testing teams to determine their proficiency in using the testers. Senior AO's should make recommendations or changes that will bring the teams to a high state of proficiency.

The missile launcher, the klystron tuner, and the aircraft's wiring are tested with the



AO.538

Figure 6-12.—Mk 5 safety arming device.

AN/ASM-9 Simulator Test Set. This tester is discussed later in this chapter.

The senior AO, to adequately perform his duties, must have properly trained junior ordnancemen who are aware of the correct techniques of testing. Only if the ordnanceman is properly trained, knows the proper sequence of operation, and is aware of the dangers involved in test equipment will he be capable of maintaining missiles. This is accomplished only through proper supervision and training by senior AO's.

AN/ASM-9, Simulator Test Set

This unit when attached to a missile launcher simulates the load presented to the aircraft by the missile, monitors the missile system control functions generated in the aircraft, and provides signals for checking the missile's klystron tuner in the launching aircraft. It also checks continuity and safety of aircraft wiring associated with the missile. The simulator test set determines whether the aircraft facilities for launching Sparrow III missiles will operate properly. The d-c power normally delivered to the missile is checked by resistance and blower motor loads. Meters and indicator lights are provided for monitoring various electrical quantities that are supplied to the missile by the launching aircraft. This instrument draws upon the aircraft for its power and no external power is required.

For further details on the operation and maintenance of the AN/ASM-9 Simulator Test Set, the AO should refer to the Operation and

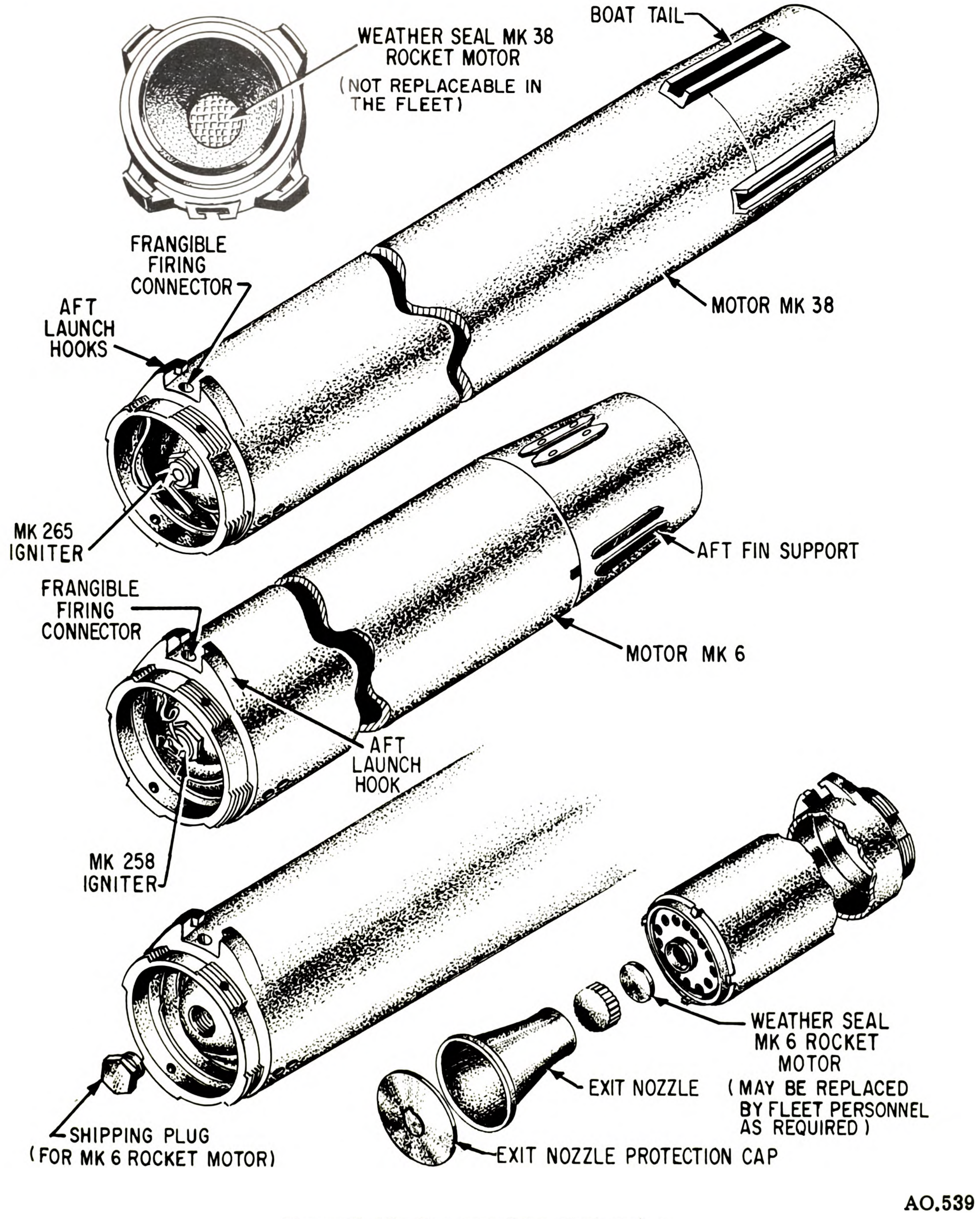

BOAT TAIL
WEATHER SEAL MK 38 ROCKET MOTOR (NOT REPLACEABLE IN THE FLEET)
FRANGIBLE FIRING CONNECTOR
AFT LAUNCH HOOKS
MOTOR MK 38
MK 265 IGNITER
AFT FIN SUPPORT
FRANGIBLE FIRING CONNECTOR
MOTOR MK 6
AFT LAUNCH HOOK
MK 258 IGNITER
WEATHER SEAL MK 6 ROCKET MOTOR (MAY BE REPLACED BY FLEET PERSONNEL AS REQUIRED)
EXIT NOZZLE
SHIPPING PLUG (FOR MK 6 ROCKET MOTOR)
EXIT NOZZLE PROTECTION CAP
AO.539

Figure 6-13.—Sparrow III rocket motor.

Service Instruction Manual, NavAir 16-30-ASM9-501 (or latest revision), or other appropriate publications.

AN/DPM-7A Test Set, Guided Missile

The missile test set AN/DPM-7A is used on operational checks of the guidance and control section of the Sparrow III missile. This tester is designed so that it can be used by either landbased or shipboard missile testing teams.

After applying external power and energizing the tester and unit to be tested, the operational testing is initiated by applying power through mechanical and electrical command inputs. The tester monitors and records the outputs of the section under test. The operator analyzes the command readings and determines if the section under test is functioning properly.

To properly use and maintain the above mentioned tester always refer to the Technical Manual Intermediate Depot Instructions, Test Set, Guided Missile AN/DPM-7A NavAir 16-30 DPM 7-3, or an equivalent publication.

Due to the complexity of the AN/DPM-7A, only qualified personnel should be permitted to operate the equipment.

AN/DSM-32 Test Set, Guided Missile

The AN/DSM-32 (or AN/DSM-32(A) test set is used for a complete and rapid check on the guidance and control component of the Sparrow III missile. This consolidated tester is used by testing teams aboard aircraft carriers or land-based installations.

Operation of the AN/DSM-32 tester actuates regulated electrical and hydraulic fluid flow, plus simulated flight in the form of microwave command and control signals to the unit being tested. Monitoring the unit being tested is accomplished by meter presentations, indicator lamps, or cathode-ray tube indications.

The AN/DSM-32 test set is a very complex precision piece of equipment and should only be used by qualified personnel. The senior AO should insure that the appropriate publications are available to the operator when performing operational tests. For further details on the tester, the AO should consult NavAir 16-30DSM32-D (latest revision).

SHRIKE

For many years a simple, inexpensive air-to-surface missile capable of neutralizing enemy radar has been needed. Various systems were considered, but the first acceptable system to become fully operational and used by the Navy in Vietnam was the Shrike missile. It was developed by the Naval Ordnance Test Station (NOTS), China Lake, California.

The Shrike missile (fig. 6-14) is designated as the AGM-45A guided missle and is a passive air-to-surface, all-weather, tactical missile whose mission is to acquire, home on, and destory enemy radar transmitters directing ground antiaircraft or surface-to-air guided missiles (SAM's).

The Shrike missile has been operational for some time and has been used in Vietnam with a relatively good degree of reliability and accuracy. Many early problems such as narrow bandwidth and antenna of the guidance system, which limited the effectiveness of the Shrike missile in the early stages of its introduction in the Vietnam war, have been overcome.

The Shrike missile consists of four major sections–the guidance section, the armament section, control section, and the propulsion section. As depicted in figure 6-14, the Shrike missile uses control surface wings and tail fins in guidance of the missile to the target. Many of the various Mks or Mods of the explosive components are interchangeable and compatible. These sections are discussed in greater detail in the following paragraphs; however, the reader should realize that most of the information pertaining to the Shrike missile and its associated components is classified and therefore is not discussed in detail in this manual.

The Shrike tactical missile is painted white. The dummy missile, which is used for handling and loading exercises, is painted blue. Training components for the missile are also painted blue. Yellow bands are used to indicate the presence of high explosives and brown bands to indicate low explosives.

GUIDANCE SECTION

This section employed in the Shrike missile is all-weather passive radar homing system. It is a highly sophisticated system which utilizes the radiation emitted by the enemy search radar as a means of homing in on the enemy system and destroying it.

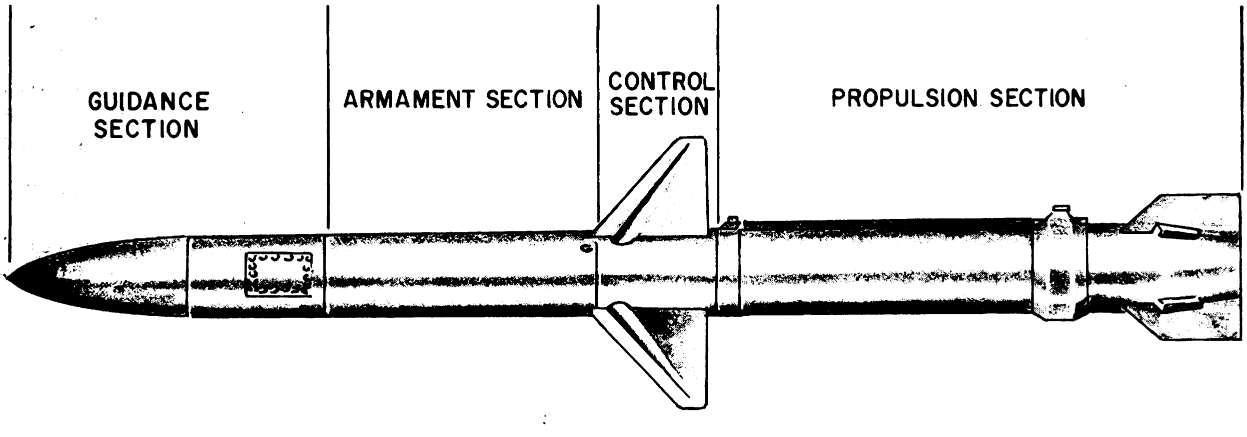


Figure 6-14.—Shrike antiradiation missile, AGM-45A.

The guidance section has a fiberglass and ceramic radome at its forward end and contains proximity fuze circuitry in a target detecting device in its after end. It is joined to the armament section by screws.

The various versions of the tactical guidance section are all identical except for their operational characteristics. The Type I trainer has still another version.

ARMAMENT SECTION

The armament section of the missile contains the explosive charge to be detonated to destroy the enemy's radar system. This section can be varied in relation to the type and construction of the target it is to be utilized against. The present armament section consists of a Mk 52, Mk 68, or Mk 69 warhead; a Mk 330 Mod 0 fuze; a Mk 44 Mod 0 fuze booster; and a cable assembly. The Mk 52 Mod 0 and Mk 68 Mod 0 tactical warheads contain steel cubes for destroying the enemy installation. These warheads are identical, except the Mk 68 Mod 0 warhead has a shaped charge in the forward-end head closure. The Mk 69 Mod 0 warhead contains white phosphorus (WP) in place of explosives and steel cubes. The Mk 69 Mod 0 warhead also has a shaped charge in the forward headed enclosure. All three of these warheads function in the same manner. The warheads can be detonated either by the target detection device or by the contact fuze upon initiation by explosion of the booster charge.

CONTROL SECTION

There are several control sections employed by the Shrike missile; however, these control sections are basically the same except for some internal configuration changes. The control section contains a gas generator and igniter, two thermal batteries, five squib switches, a hot gas manifold, a wing deflecting mechanism, and associated electrical circuits. The control section receives the initiating signals from the aircraft or guidance section, and disseminates and forwards the signals for proper missile performance. The gas generator provides pneumatic pressure for pistons that turn the wing control shafts during terminal guidance. The five squib switches within the control section provide control circuit functions from the missile prelaunch through the terminal guidance phase.

PROPULSION SECTION

The propulsion section consists of the rocket motor, igniter, and the igniter safe/arm actuator. The rocket motor is a short-duration, medium thrust, self-contained propulsion unit employing a solid propellent grain. The forward end of the rocket motor contains the igniter arm actuator and the igniter.

The rocket motor functions in the following manner: Firing current is applied to the igniter which, when it burns, in turn initiates burning of the motor propellent grain. This in turn causes the motor chamber pressure to rise, causing the weather seal on the motor nozzle assembly to burst. Hot gases are then expelled through the nozzle exit cone creating thrust to the missile.

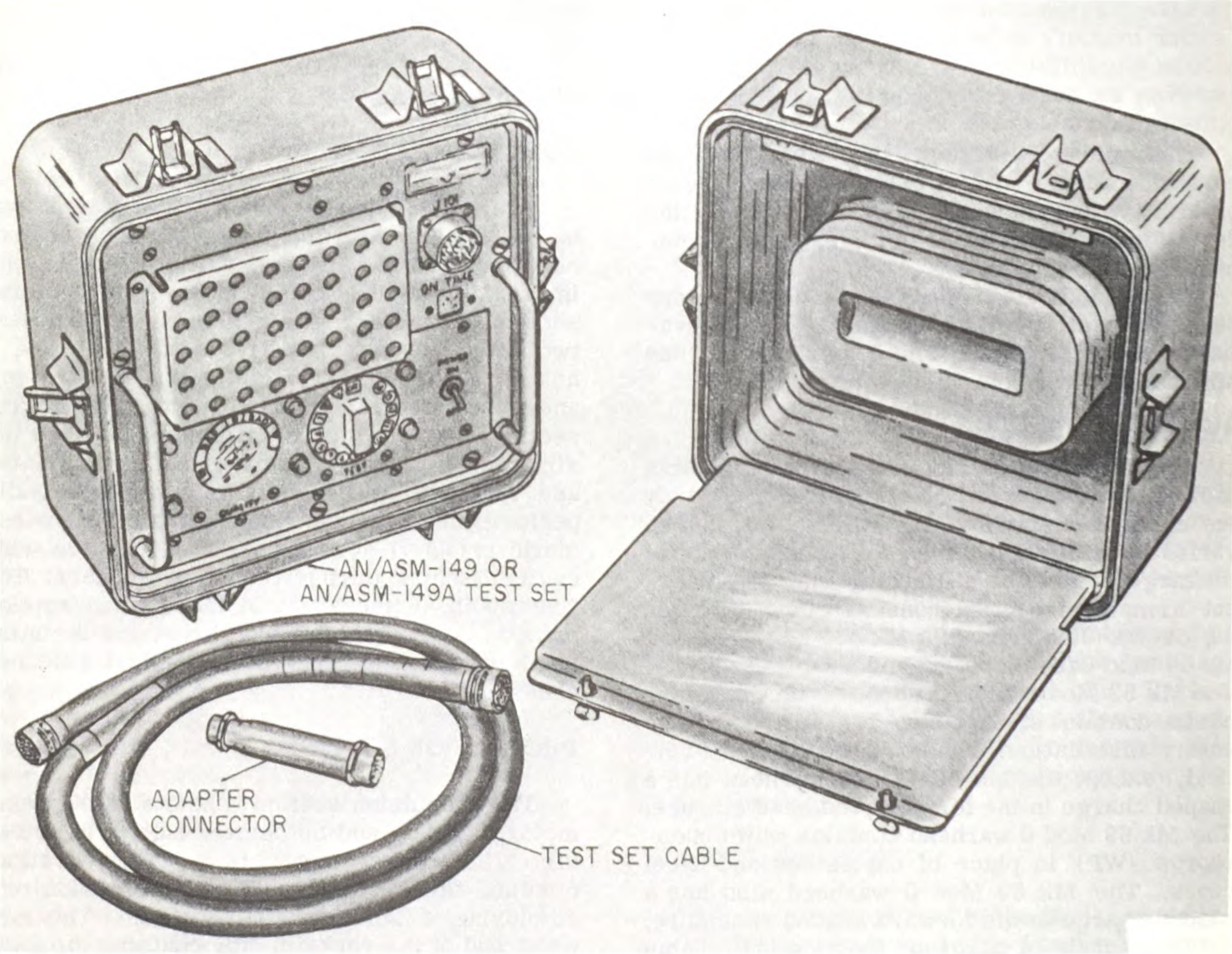
TESTS AND TEST EQUIPMENT

The test performed on the Shrike missile, other than those conducted during assembly, are limited to a visual inspection of the missile and a preflight check of the aircraft and launcher system.

Test Set, Guided Missile and Launcher AN/ASM-149

The AN/ASM-149 (or AN/ASM-149A) tester (fig. 6-15) is used to check the aircraft and launcher circuitry of the Shrike weapons system. The tester consists of a selector knob, a special purpose voltmeter, and an interconnecting cable.

Input voltages from the aircraft and launcher circuits are indicated as "good" or "bad" on the tester voltmeter. A transformer in the tester provides a tone signal (simulating the missile)



AO.541

Figure 6-15.—Test Set Electrical Circuit, Guided Missile and Launcher AN/ASM-149.

to determine the operation of the audio circuits of the aircraft.

Recent modifications to the test set have incorporated various input signals which are displayed on the aircraft radarscope to indicate missile boresight and guidance functions.

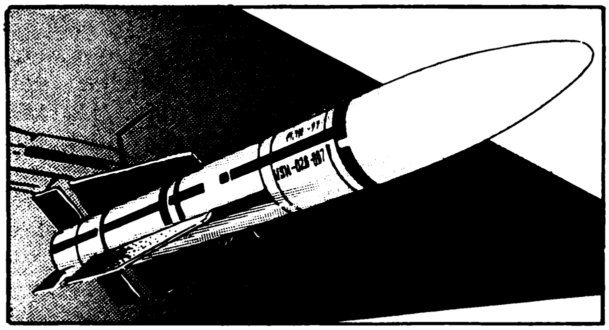
PHOENIX

The Phoenix missile is an air-to-air missile that is presently in the experimental stage. The 156-inch missile employs a single stage solid propellent motor which is 15 inches in diameter. It is designated as the AIM-54A and was designed to be used with the F-111B and F-14 aircraft. (See fig. 6-16.)

The Phoenix has many advantages over the present air-to-air missiles presently operational in the fleet. Detailed information on it is classified, but a few of the more pertinent facts that make the missile so superior to present operational air-to-air missiles are as follows:

1. Multiple missile tracking and launch capability—the interceptor aircraft can be armed with six Phoenix missiles which can be launched from the aircraft at six separate targets in rapid sequence. The capability to fire and control these missiles is a reflection of the ability of the weapons system to track several targets on a time-shared basis while it scans the sky for other targets.

2. The Phoenix is substantially a longer range missile than other air-to-air missiles; this is a result of the ability of the guidance system combined with the long range ability of the pulse Doppler fire control radar.



AO.542

Figure 6-16.—Phoenix missile.

3. Due to the "simultaneous launch" capability of the F-111B aircraft and the fact that the Phoenix missile travels, its maximum range in less than 2 minutes from release, the interceptor has the capability of launching six missiles at six different targets in less than 2 minutes.

Phoenix is designed to operate in an electronic countermeasures environment where its multiple guidance phases and multiple control frequencies make it effective against all predicted ECM techniques. The F-14 Tomcat will carry six Phoenix missiles on special removable pallets which may be removed for its "dogfight" configuration. Phoenix, together with the F-14/AWG-9 missile control system, will combine an advanced high power pulse Doppler, look-down, track-while-scan, multishot radar and fire control system with a long-range mid-course guidance, terminal homing missile. The AWG-9 will also display firing envelope information, for Phoenix and all other weapons (Sparrow, Sidewinder, Agile, and the M61 gun) under maneuvering environments, to the pilot's heads-up display. The Phoenix/AWG-9 systems' digital computer allows the tracking of a large number of targets while the radar continues to scan for new targets. Test flights of R&D models of Phoenix have resulted in unprecedented successes, including a hit at 78 miles, simultaneous launch of two missiles on two widely separate targets, each recording a kill and destruction of drones in "look-down" attacks where conventional radars would have been confused by ground clutter.

AGILE

Not as far along in development, but certainly a radical departure from previous design, is the Navy's future "dogfight" missile — Agile. This missile will have no wings and only very small stabilizing fins. Directional control will be provided by a swiveled propulsion nozzle which will introduce the first use of thrust vector control into a tactical missile. Agile is the planned replacement for Sidewinder. Its approximate 8-foot length makes it slightly shorter than Sidewinder, but its warhead is considerably more effective, and its maneuverability is remarkably increased over its predecessor. Agile's turn radius is better than anything that flies. A forward-fired Agile can turn and attack a target to the rear of the launching aircraft. This capability naturally greatly increases launch opportunity due to the enlarged operating envelope. Further, an aid to the pilot in employing this weapon is the planned use of a helmet-mounted sight tied to the missile's detection/tracking system, allowing the pilot to fire on anything he can see. Fleet introduction for this deadly weapon is planned for the late 1970's. Figure 6-17 shows the Agile during a test flight.

WALLEYE GUIDED WEAPON

The Mk 1 (Mods 0, 2, 6, and 7) guided weapon, commonly known as Walleye, is air-launched and self-guided to selected surface targets. The weapon is comprised of a guidance section, a warhead section, a control section, four wings, and four fins. The weapon incorporates an automatic television guidance system, an aerodynamic fin control for flight course correction, and a ram air turbine-driven electrical generator for internal power. The Walleye is suspended from the launch aircraft by either of two sets of bomb lugs (14 or 30 inches). Figure 6-18 shows the Mk 1 Mods 0 and 2 Walleye guided weapon.

The Mods 6 and 7 differ from Mods 0 and 2 in that the Mods 6 and 7 utilize an improved guidance and control section for increased weapon system reliability.

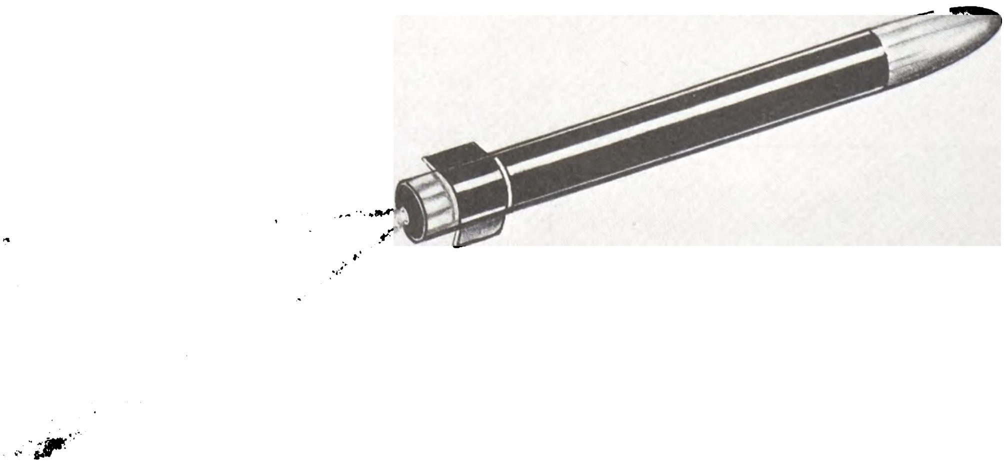
The components, operation, and other pertinent information are discussed in this chapter so that the AO supervisors not assigned to billets involving this weapon system will have a basic understanding of the Walleye weapon system.

GUIDANCE SECTION

The guidance section comprises the forward section of the weapon. A sealed, pressurized forward compartment contains a gyro-stabilized vidicon camera tube, a telescopic lens, a red filter, and a torquer and linkage system. The dome of the guidance section is protected against damage by a dome protective cover, which is removed during testing and after the weapon is loaded on the launch aircraft. The rear compartment contains the guidance power supply and an electronics assembly containing the electronic video tracking circuits. All electronic components in the guidance section are transistorized with the exception of the vidicon tube. Two connectors are provided at the open end of the guidance section. One connector is used for test purposes and the other connects to the warhead section wiring harness during assembly. Guidance sections are painted white.

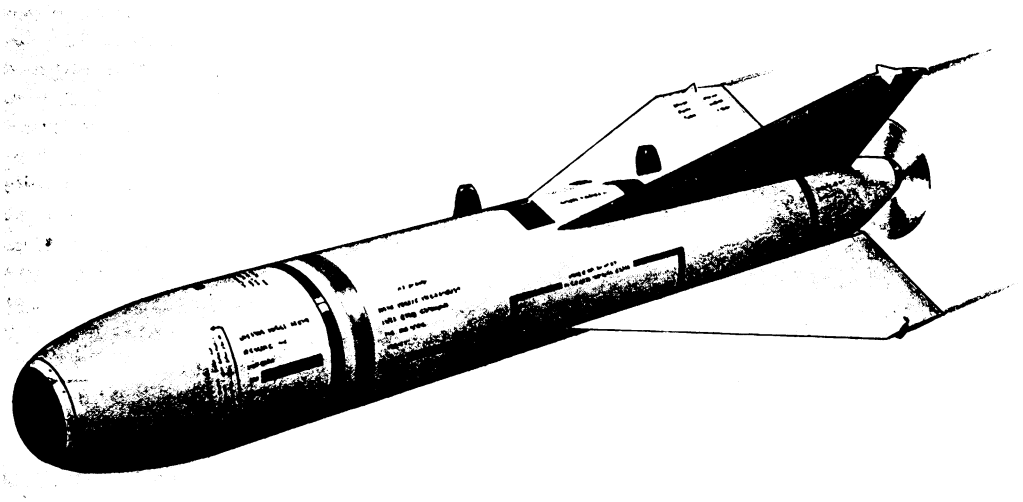
WARHEAD SECTION

The warhead section is located in the center section of the weapon, comprised of a Mk 58



AO.543

Figure 6-17.—Agile missile.



AO. 544

Figure 6-18.—Mk 1 Mods 0 and 2 Walleye guided weapon.

Mod 0 or 2 loaded warhead, a Mk 328 Mod 0 fuze, a breathing system, an rfi filter, and a wiring harness. The previous items are assembled into the Mk 1 Mod 0 or 2 warhead at the Naval Weapons Station (NWS). The breathing system is pressure equalizing and contains an air drying system that prevents condensation when the weapon is in captive flight, ground stowage, or loaded on the aircraft. The breathing system has a color indicator to denote the degree of moisture saturation of the desiccant. Tactical warheads are painted white and marked with a 2-inch yellow band, which indicates that they are a high explosive.

CONTROL SECTION

The control section comprises the aft end of the weapon. The forward part of the control section contains an electronic package assembly. The aft end of the control section contains the hydraulic servo-system and the ram air turbine generator. The ram air turbine blades are protected against damage by a protective cover, which is removed during testing and after the weapon is loaded on the aircraft. Two connectors are provided at the open end of the control section. One is used for test purposes and the other connects to the warhead wiring harness when the sections are joined together. Control sections are painted white.

WINGS AND FINS

One set of four wings and four fins is supplied in a separate container for each weapon. The wings are delta shaped and are mounted in a cruciform configuration. They are installed in locking holes of the weapon body wing mounts and secured with a wrench. The fins are installed, without the use of tools, in self-locking inserts. Wings and fins are also painted white.

OPERATION

In accomplishing its mission, the weapon performs six primary functions as follows:

1. Generates electrical power required in its operation.
2. Provides a video display of the target area to the launch aircraft television monitor.
3. Tracts the selected target.
4. Controls the release sequence of operations.
5. Controls its flightpath to the target.
6. Arms the explosive warhead fuze.

Weapon Power

The ram air turbine driven by a variable pitch propeller with a velocity governor, provides weapon electrical power when aircraft speed exceeds approximately 180 knots. The weapon control section houses the ram air turbine and the electrical distribution circuits necessary for control of system power to the weapon power supply circuits. When aircraft speed is less than approximately 120 knots, aircraft electrical power is provided the weapon.

A power changeover circuit, sensing the voltage output of the ram air turbine, automatically determines the selection of aircraft power or weapon system power. If the ram air turbine output is greater than 101 volts, ram air turbine power is selected. If the ram air turbine output is below 101 volts, aircraft power is selected. After weapon launch, interlock circuits within the weapon cause the ram air turbine to deliver system power to the weapon power supply circuits regardless of the ram air turbine output voltage value.

The power changeover circuit provides a weapon ready indicator signal (ground) to the aircraft weapon ready indicator whenever the power changeover circuit switches to ram air turbine power. Before launching of a weapon, the aircraft weapon ready indicator must be lighted continuously. Launch cannot be accomplished unless the weapon is operating on ram air turbine power.

Video

The weapon uses a vidicon camera tube with associated video circuits to generate the video picture of the target area. The guidance section of the weapon contains optical, video, and tracker circuits for generating the composite video signal and tracking the target.

The optical circuit, containing the vidicon camera tube and lens, converts the target image into an electrical signal (raw video). This signal is then processed in the video circuit to produce the composite video signal. The video circuit also generates the operating voltages for the vidicon camera tube. The tracker circuit provides the crosshair signal input to the video circuit. The crosshair signals are added to the video signal and displayed on the pilot's television monitor as a pair of vertical and a pair of horizontal lines.

Target Tracking

The Walleye uses an automatic television guidance system to track the target. This system, located in the guidance section, consists of the tracker circuit (electronic tracking) and the camera-positioning circuit (mechanical tracking).

ELECTRONIC TRACKING.—The tracker circuit operates in two modes: prelock-on and lock-on. In the prelock-on mode, the tracker circuit generates the vertical and horizontal crosshair signals that are added to the video signal. Sync pulses from the video circuit establish the timing reference for the crosshair signals. In this mode, the crosshairs are fixed in position and establish the tracking area.

In the lock-on mode, the tracker circuit, operating from the raw video signal from the video circuit, generates azimuth and elevation tracking error signals whenever the target is not centered within the crosshairs. The crosshair signals are repositioned in this mode to indicate visually to the pilot that the weapon is tracking. A target remaining within the crosshairs is being tracked.

MECHANICAL TRACKING.—The camera-positioning circuit controls the elevation and azimuth position of the camera tube, using a gyro-stabilized two-degree-of-freedom gimbal system and an associated torquer and linkage system. The camera-positioning circuit operates in three modes—mechanical cage, mechanical uncage, and track.

In the mechanical cage mode, the torquer and linkage system is physically locked to maintain the vidicon camera tube in a boresight position. This condition is established when the weapon station is in an off condition. In the mechanical uncage mode, the torquer and linkage system is uncaged but maintains the vidicon camera tube locked to a boresight position. In the track mode, the torquer and linkage system responds to the azimuth and elevation tracking error signals to reposition the vidicon camera tube so that the optical axis of the vidicon camera tube is always on the line of sight to the target.

Tracking Operation

The uncage mode starts when a weapon station is selected by the pilot. Guidance section energize and uncage signals (28 volts d.c.) are applied from the aircraft to the selected weapon. The guidance section energize signal, applied to the guidance section power supply, energizes the power supply, which develops operating voltages for the guidance section. The uncage signal energizes a relay within the guidance section power supply. This relay then routes an uncage signal from the power supply to the camera-positioning circuit that uncages the tracking system of the weapon. The tracking system (camera-positioning circuit) uses the two-degree-of-freedom gimbal system to control the azimuth and elevation position of the weapon vidicon camera tube.

During station select operation, the tracking system is maintained electrically caged along the boresight axis of the weapon. This is accomplished by the trigger signal from the aircraft energizing the trigger lock-on relay, which closes the torquer reference loop to establish the boresight reference. After the pilot selects a target, he presses and holds the lock-on (trigger) switch. This removes the trigger signal, deenergizing the trigger lock-on relay, and opens the torquer reference loop and closes the azimuth and elevation tracking error loop.

In the track mode, the vidicon gimbal system is free to move in azimuth and elevation. The boresight axis of the vidicon tube is always maintained on a line of sight to the target. The tracker circuit electronically compares the target position to the crosshair position in the television frame. Deviation of the target from a centered position generates representative tracking error signals. These signals are routed to the camera-positioning circuit, where they cause mechanical repositioning of the vidicon tube to a target-centered position by use of the torquer and linkage system.

The camera-positioning circuit also develops guidance error and gimbal angle signals for use by the control section of the weapon, after launch, to control the flightpath of the weapon. Guidance error signals (azimuth and elevation) are rate signals that are a function of target displacement distance from crosshair center. Gimbal angle signals (azimuth and elevation) are displacement signals that are a function of angular camera axis displacement with respect to the weapon longitudinal axis.

The tracker circuit also provides signals that reposition the crosshairs on the television frame so that the crosshairs are always centered about the target. Cumulative action of correcting crosshair position and vidicon camera position maintains electronic and mechanical tracking of the target..

At any time prior to launch, the pilot may abort his attack. Release of the lock-on switch electrically cages the guidance section.

Release

The weapon incorporates an intent-to-launch interlock circuit and various relay circuits to accomplish weapon release. The intent-to-launch interlock circuit insures that certain conditions are met by the weapon prior to actual weapon release. The relay circuits consist of a launch relay, a fuze arm relay, and a guidance delay relay.

INTENT-TO-LAUNCH INTERLOCK CIRCUIT.—The weapon incorporates an interlock system to insure that the weapon systems are operational before weapon release. The interlock circuits are located in both the guidance and control sections of the weapon.

Interlock provisions in the guidance section insure that the weapon camera-positioning circuit is mechanically and electrically uncaged and that the aircraft-supplied trigger signal has been removed. Interlock provisions in the control section uncage the roll gyro, and then insure that the roll gyro is uncaged and that the power changeover circuit has selected ram air turbine power for the weapon. When all provisions have been met by the interlock circuits, the launch relay is energized.

The release function is controlled by the intent-to-launch signal from the aircraft. The intent-to-launch signal (+28 volts d.c.) is routed through the guidance power supply, where it functions to insure that mechanical and electrical uncaging has occurred. The signal is then routed through the deenergized trigger lock-on relay, insuring trigger signal removal, and then to the control section electronics circuit, where it uncages the roll gyro and insures that the roll gyro is uncaged. Finally, the signal energizes the launch relay if the power changeover circuit has selected ram air turbine power for the weapon. When these conditions are met, the intent-to-launch signal applied to the launch relay is routed to the aircraft as an intent-to-launch rack signal and the weapon is ejected.

LAUNCH RELAY CIRCUIT.—The launch relay circuit is controlled by four signals from the aircraft. The trigger signal (prior to station select) and the guidance section energize signal (after station select) use the aircraft power ground signal to latch the launch relay in the deenergized position. Weapon launch cannot occur until ram air turbine power is sufficient to cause the power changeover circuit to change over to ram air turbine power. Whenever the weapon is operating on ram air turbine power, the aircraft power ground is removed by the power changeover circuit. This removes the deenergize latch on the launch relay, allowing the intent-to-launch signal to energize the launch relay.

The launch relay circuit controls the energizing of various weapon control functions. Energizing of the launch relay routes activation signals to the control section circuits. A servo run signal (+ 28 volts d.c.) energizes the hydraulic servosystem. A roll amplifier integrator relay signal (-28 volts d.c.) unclamps the roll amplifier integrator circuit. A gain changer disable signal (-28 volts d.c.) is removed from the control electronics circuit to enable the control electronics circuit to control signal gain.

A guidance power hold signal (+28 volts d.c.) is routed to the guidance power supply. This signal replaces the guidance energize signal, which is removed at missile ejection, to maintain continuous operation of the guidance section circuits. A pre-launch elevation bias signal, a down command that prevents fin flutter by use of undumped hydraulic servo pressure, is removed from the control electronics circuit, and the gravity trim signal is applied.

A fuze arm signal (+ 28 volts d.c.) is routed to the fuze and to the fuze arm relay, which then applies a +150-volt d-c fuze arm signal to the fuze. Both voltages (+28 volts d.c. and +150 volts d.c.) are used in the fuze mechanism arming sequence after weapon release.

FUZE ARM RELAY CIRCUIT.—The fuze arm relay, when energized by the launch relay +28-volt d-c signal, applies a +150-volt d-c fuze arm signal to the fuze. For weapon testing purposes, the fuze arm relay is bypassed while the weapon is energized. A fuze by-pass relay, when energized, interrupts the 28-volt d-c lead to the fuze and fuze arm relay, and provides a ground signal for a fuze bypass indication (SAFE), which indicates fuze bypass relay operation. With the fuze arm relay deenergized, the +150-volt d-c source is interrupted and the +150-volt d-c lead to the fuze is grounded.

GUIDANCE DELAY RELAY CIRCUIT.—The weapon incorporates provisions to delay the application of the azimuth and elevation guidance error signals to the control electronics circuit after release. This delay prevents the guidance error signal from affecting the flight of the weapon during initial release conditions.

At release, the aircraft-provided guidance delay ground signal to the guidance delay relay is removed. This initiates a 2-second delay in the relay before it is energized. Energizing of the relay routes the azimuth and elevation guidance error signals to the control electronics circuit.

Flight Control

The weapon uses the control electronics circuit to provide fin command signals to the hydraulic servosystem. The fin command signals represent the direction and amount of fin torque required to maintain the weapon on a straight-line course to the target. Fin torque is controlled by hydraulic servo solenoids that respond to fin command signals and allow hydraulic pressure to torque the fins, thereby causing flight-path correction. The control electronics circuit uses elevation and azimuth channels, a roll circuit, a dither circuit, and four servoamplifiers (right-up, right-down, left-up, and left-down) to provide the required fin command signals.

ELEVATION AND AZIMUTH CHANNELS.—The elevation (pitch) and azimuth (yaw) channels are essentially identical in operation. Each channel consists of a damping circuit, a variable gain amplifier, an inverter circuit, and a gain changer/accelerometer circuit that is common to both channels. The channels combine their respective guidance error and gimbal angle signals, which are supplied from the guidance section, and a fixed gravity trim signal (elevation channel only) to provide control signals to the servo amplifiers.

The damping circuit differentiates the gimbal angle signal and provides a rate signal input to the variable gain amplifier. The variable gain amplifier combines the differentiated gimbal angle signal, the fixed gravity trim signal (elevation channel only), and the guidance error signal, producing an output control signal to the servoamplifiers.

The gain of the variable gain amplifier is controlled by the gain changer/accelerometer circuit. The gain changer integrates the summation of the guidance error signal, the gravity trim signal, and the accelerometer signal to provide a signal that controls the variable gain amplifier. Weapon acceleration in the Y-axis, sensed by the accelerometer, provides a signal to the gain changer that causes the respective channel output signal to be multiplied by a factor between 1 and 3. The gravity trim signal, subject to multiplication by the variable gain amplifier, provides a constant up signal to aid in maintaining the straight-line flightpath of the weapon.

The pitch control signal is the output of the pitch variable gain amplifier and is applied directly to the left-up and left-down servoamplifiers, and through the pitch inverter circuit that inverts the signal, to the right-up and right-down servoamplifiers. The yaw control signal is the output of the yaw variable gain amplifier and is applied directly to the right-down and left-down servoamplifiers, and through the yaw inverter circuit to the left-up and right-up servoamplifiers.

ROLL CIRCUIT.—The roll circuit consists of a roll gyro and a roll amplifier. The gyro senses the roll attitude with respect to the normal flight up position and provides a voltage input to the roll amplifier. A roll rate signal is provided by the roll amplifier to all four servoamplifiers.

DITHER CIRCUIT.—The dither circuit operates as a free-running multivibrator, applying a constant input signal to the servoamplifiers regardless of weapon maneuvers. The dither signal causes the hydraulic servo valves to oscillate at very low amplitudes, reducing servo valve hysteresis.

SERVOAMPLIFIERS.—The four servoamplifiers are common to the two channels (elevation and azimuth), the roll circuit, and the dither circuit. Each servoamplifier sums the total of the inputs to provide a fin command correction signal for its respective hydraulic servo valve.

Detailed information as to the operation of the Walleye and other pertinent information may be found in NavAir 01-15MGA-2.

Fuze Arming

Fuze arming data is of a higher classification than this manual and is contained in supplemental manual NavAir 01-15MGA-2A.

FLEET MAINTENANCE

The most efficient manner of accomplishing the maintenance requirements is to perform a thorough inspection of the weapon to determine whether or not there is physical deterioration beyond the maintenance capability of the local facility. If repair is within the maintenace capability of the local facility, the cleaning, repairing, painting, and stenciling required to restore the weapon to a ready-for-use condition should be performed. Upon completion of repairs, the weapon is tested using the AN/DSM-92 test set prior to issue. If the damage is beyond the maintenance capability of the local facility, the weapon must be returned to the NWS, with documentation indicating the reason for returning the weapon.

Disassembly of the weapon, except for wings, fins, and suspension lugs, is beyond the capability of fleet maintenance. Therefore, fleet maintenance will primarily consist of inspection of the weapon, removal of any accumulations of dust, dirt, or corrosion, replacement of damaged suspension lugs, removal of loose paint, and repainting of areas that would be subject to corrosion damage.

Fleet maintenance pertains to all intermediate maintenance activities (shipboard and shorebase) other NEWS actitives. NavAir 01-15MGA-2 outlines the fleet maintenance capabilities for the cleaning, inspection, repair, painting, and stenciling procedures used to best fulfill the weapon maintenance requirements.

STOWAGE

Walleye Weapon System shipping and stowage containers are stowed in accordance with the general requirements of NavOrd OP 5, Ammunition Ashore. The assembled weapon and explosive components must be stowed in approved magazines and be protected from weather, fire, and nearby explosion propagation. Grounding precautions must be observed for each container or palletized load. Inert components are stowed in an inert stowage area.

The stowage area temperature must be maintained between -70° F and +160°F, or weapon component operational limits may be exceeded. Humidity indicator inspections must be performed every 180 days for containers in stowage. Containers with WET indications are rejected and disposed of as prescribed in NavAir 01-15MGA-2.

Stowage arrangements vary, depending on the availability and types of stowage areas. Stacking of containers and palletized loads is permissible. The Mk 426 Mod 0 shipping and stowage container may be stacked four high. All other containers are limited to a stack height not exceeding the normal height of four palletized loads.

Assembled weapons in containers have a 5-year shelf life. Weapon sections and the wings and fins in containers have a 2-year shelf life. Mk 328 Mod 0 Fuze component parts in a container have an 8-year shelf life. The miscellaneous warhead component parts are packed in a container with the warhead and have a 2-year shelf life. All shelf-life periods commence upon the date of receipt.

Ready-Service Stowage.

Assembled weapons may be maintained in ready-service stowage. Table 6-1 lists the two stowage conditions of ready-service stowage and the maximum allowable time interval between humidity inspections. Damage or malfunctioned assembled weapons must not be maintained in ready-service stowage. Immediate disposition as prescribed in NavAir 01-15MGA-2 is mandatory.

Humidity Limitations

The weapon warhead section contains a breathing system with desiccant and a humidity indicator. The humidity indicator has three indications: DRY, 9-MONTHS REMAINING, and WET. A wet indication is cause for weapon rejection.

Table 6-1.—Ready-service stowage conditions.

Stowage Condition	Humidity inspection interval
In building with sides and roof.	30 days
Outside, covered with tarpaulin.	7 days

WEAPON LOGBOOK ASSEMBLY

The Walleye Weapon Logbook consists of the following forms:

1. Fuze safety inspection tag.
2. Walleye Weapon System—Equipment History and Operating Log—Armament, 11ND/FMSAEG-8812-7/4.
3. Walleye Weapon System—Equipment History and Operating Log—Guidance, 11ND/FMSAEG-8812-7/1.
4. Walleye Weapon System—Equipment History and Operating Log—Control, 11ND/FMSAEG-8812-7/2.

The weapon logbook is originated at the NWS. The fuze safety inspection tag and the Armament (section) Equipment History and Operating Log form are initiated at the NWS. Guidance and Control (section) Equipment History and Operating Log forms are packed with the sections by the manufacturer and must be removed from the record holder of the shipping container when the sections are unpacked. Detailed instructions for entering data on each of the equipment history and operating log forms are prescribed in FMSAEG Instruction E-5-68-1.

The logbook accompanies the assembled weapon throughout the logistics flow until the weapon is either disassembled or expended. Logbook entries are made when the weapon is assembled and every time the weapon is tested. When a weapon is disassembled for replacement of a section, the Equipment History and Operating Log for the removed section remains with the section. The logbook receives the replacement section Equipment History and Operating Log form. For record purposes, the serial number of the assembled weapon is the serial number of the armament section.

When a weapon has been expended, the weapon logbook, with all pertinent data completed, must be sent to the U.S. Naval Fleet Missile Systems Analysis and Evaluation Group (FMSAEG), Corona, California 91720.

WALLEYE PRACTICE WEAPONS

There are three practice weapons that are used for different types of training. The Mk 2 Mod 0 practice weapon is used for free-flight tests. It is essentially identical to the Mk 1 Mod 0 tactical weapon, except that the warhead is inert. The Mk 2 Mod 0 practice weapon can be identified by its blue warhead. The Mk 328 Mod 0 fuze is used with the inert warhead to provide a visual indication of proper fuze functioning on impact. After the explosive Mk 328 Mod 0 fuze is installed, a 2-inch yellow band is painted around the warhead to indicate that it is explosive.

The Mk 4 Mod 0 practice weapon is used for the training of pilots, handling personnel, and ordnance system maintenance personnel. This weapon is not normally launched during a flight but may be jettisoned if necessary. The Mk 4 Mod 0 weapon is completely inert and may be stowed as inert material.

The Mk 4 Mod 1 practice weapon is used primarily to train pilots in target acquisition and launch procedures. This weapon is not intended for launch but may be jettisoned in an emergency. The Mk 4 Mod 1 contains a video tape recorder (VTR) in the warhead section that records the video scene during approach to the target and simulated launch of the weapon. After flight, the pilot may review the VTR tape which is complete with sound. Stowage of the Mk 4 Mod 1 practice weapon is the same as the Mk 4 Mod 0; that is, inert stowage areas.

Testing of the three different practice weaponds is accomplished in the fleet by use of the AN/DSM-92 test set. Test procedures for all three practice weapons is contained in NavAir 01-15MGA-2.

STANDARD ARM GUIDED MISSILE (AGM-78A)

The Standard Arm, designated as the AGM-78A, is an air-launched, supersonic, guided missile employed against surface targets that emit a source of electromagnetic radiation. The prime target for the Standard Arm is radar installations. The missile consists of eight major subsystems—guidance system, autopilot, battery power system, steering control unit, propulsion, airframe, ordnance system, and strike aids. The Standard Arm weapon system includes a missile launch adapter which provides an aircraft with the means for carrying and launching the missile. Additional information on the Standard Arm missile is classified and cannot be discussed in this manual.

MISSILE TARGET AQM-37A

The AQM-37A is an expendable, rocket powered missile target, capable of flying at high altitudes and supersonic speeds. It is designed for straight and level flight at various preselected altitudes and speeds to simulate high performance aircraft. The AQM-37A is used for evaluation and training of operational air-to-air or surface-to-air missile weapon systems. This target missile is normally stowed, tested, and assembled by the guided missile division aboard a carrier.

TEST EQUIPMENT CALIBRATION

It is the policy of the Naval Air Systems Command that all test and measuring equipment under its cognizance be calibrated periodically and that participation in the established calibration program is mandatory for all NavAirSysCom managed activities.

Activities to which test equipment is provided have the responsibility for insuring that such test equipment is calibrated at specific periods or exchanged for calibrated equipment. Each NavAirSysComRep provides for scheduling weapons system test equipment into the Navy calibration laboratories under his cognizance and also stocks and issues labels, tags, and information pertaining to their use and other technical data on the calibration program.

SAFETY

In the study of safety precautions, it is difficult to cover every possible situation that may arise and which, unless properly handled, may have serious results. An attempt should therefore be made to understand the ideas upon which the precautions are based in order that unsafe conditions can be recognized and corrected and, further, that suitable action be taken instinctively when the unexpected occurs. In order to sucessfully initiate a safety program, The AO must throughly understand what safety precautions are and why and how they actually apply in practice.

Safety is more than a duty owed to authority. Where explosive ammunition is concerned, it is a way of life and a means of survival for the individual as well as his associates. Each person in the naval service is responsible for observing all safety precautions applicable to his work or duty, reporting any equipment or practices which he considers unsafe, and to warn others whom he believes to be endangered by known hazards.

Throughout the various manuals, pamphlets, and other technical publications, countless safety precautions are distributed. Some of these precautions are the result of actual incidents that have occurred, others are the product of intelligent imagination and forethought. Printed precautions alone, however, cannot prevent accidents. Safety must be explained by those who know to those who do not know. Safety consciousness must be instilled by constant supervision, adequate instruction, and careful training. Safety is both the result and reflection of good training.

Inasmuch as safety precautions are generally understood by all hands to be one of the primary laws of self-preservation, cases of willful violation are rare. Rather, it is the ignorance of their existence and application, or a "slacking off" of their meticulous observation, bred from over confidence in the nonoccurrence of accidents, that causes violations.

Specific safety precautions for each type of equipment or explosive component are too numerous to cover in this chapter. Prior to commencing any operation, the AO must consult the applicable publication concerning the hazards involved and the safety precautions to be observed.

Strict adherence to all safety precautions and the grave consequences of their violation must be of primary concern to the senior Aviation Ordnanceman.

CHAPTER 7

AIR STRIKE PREPARATION

The Aviation Ordnancemen's primary duties are stowage, preparation, loading, and unloading of aircraft ammunition and stores. With the large variety of equipment and ammunition required to ready a launch of aircraft for a tactical strike, it is virtually impossible for an individual to remember the precise loading sequence steps. To aid the AO in properly arming an aircraft, Conventional Weapons Checklists are available; these checklists eliminate the need for reliance on memory.

The senior AO is primarily concerned with the efficient supervision of his crew(s). The quality of supervision exercised by the senior AO is the most decisive factor in determining the smoothness and efficiency of the arming and dearming operations. To reach a high degree of proficiency in supervision of these crews, the senior AO must thoroughly understand the entire operation, the capacities and abilities of his crews, and the time required to arm or dearm each type of aircraft. The senior AO must also have a high degree of technical competence, for the possession of such competence is his greatest single asset in inspiring confidence and respect in the men that he will be supervising.

The senior AO must act as an overall coordinator. He does this by maintaining close contact with the flight deck officer (aboard carriers) to reserve certain areas of the flight deck for the temporary stowage of aircraft ammunition prior to the loading. (For safety, only the required quantity of ammunition should be broken out.) He must also maintain close contact with all phases of the arming and dearming process through proper supervision and delegation of authority to his arming crews. He is required to spend most of his time on the flight deck to expedite any changes in aircraft assignment and maintain close supervision of the progress of arming or dearming aircraft in the assigned order.

CONVENTIONAL STORES

The assembly and other preparatory steps required to ready ammunition for an air strike are performed in part by the support activity, carrier, or naval air station. The procedures necessary to configure and load the various stores onto the aircraft is a function of squadron ordnancemen.

Aboard a carrier, air-launched weapons are assembled below deck and delivered to a weapon staging area by personnel assigned to G or GM Division. Squadron AO's receive all ammunition and components at the staging area and then load the aircraft. The ship's Air Plan and Strike Plan (which are published daily) provides the information to G or GM Division for the ammunition requirements.

Squadron air-launched weapon requirements at a shore station are ordered on a DD Form 1348, which is submitted to the station Weapons Department. The senior squadron AO must familiarize himself with the station instructions pertaining to the local procedures for requisitioning ammunition and associated stores.

LOADING CHECKLISTS

Conventional Weapons Loading Checklists are printed in the basic format used for Special Weapons Checklists. The checklist is provided for use by loading personnel and contains abbreviations of procedures published in the NavAir manual for each type of aircraft. The checklists are published under the direction of NavAirSysCom and distributed as NavAir 01 series manuals.

The checklists are divided into several sections. (The number of sections may vary according to the type aircraft and weapon combination.) A typical manual will contain the following:

1. Table of contents.
2. Introduction/required reading.

3. Aircraft preparation/inspection.
4. Weapon inspection.
5. Weapon loading.
6. Postloading checks (quality assurance).
7. Prior to launch.
8. Abort/after landing/turnaround procedures.
9. Weapon unloading.

No carriage or electrical connection of single, multiple, or mixed loads of conventional weapons on aircraft is permitted unless authorized by the tactical manual and a specific and official NavAir Conventional Weapons Checklist. The NavAir Conventional Weapons Checklist must be used with knowledge and understanding in performing each step function. All other operational procedures performed on conventional weapons systems must conform to the procedures prescribed in appropriate NavAir Publications and Ordnance Pamphlets.

Deviations from NavAir Conventional Weapons Checklists may be authorized by the Operational Commander when necessary and required.

Stores Reliability Cards (SRC's)

An abbreviated version of the loading section of the Conventional Weapons Checklist is available for use during high tempo operations; this version is known as Stores Reliability Cards (SRC's). SRC's are shirtpocket size checklists containing procedural steps on one side; illustrations of the weapon and suspension equipment are shown on the reverse side. SRC's are numbered according to their corresponding Conventional Weapons Checklist, and their procedures are mandatory when used in lieu of the checklist.

Airborne Weapons/Stores Publication Index

The Airborne Weapons/Stores Publication Index, NavAir 01-700, is a quarterly publication that provides a listing of all current conventional and nuclear checklists, stores reliability cards, and loading manuals.

NavAir 01-700 is designed to provide all using activities (aviation units and carriers) with a guide to insure that all existing changes have been incorporated in checklists and manuals on hand, and that these publications are the most recent available.

As stated in chapter 2 of this manual, NavAir 01 series manuals may be requested individually on a DD Form 1348, using the stock number of the desired publication which may be found in this index. Automatic distribution of these checklists may be requested by submitting a NavAir Form 5605/3 to the Naval Air Technical Services Facilities (NATSF), 700 Robbins Avenue, Philadelphia, Pennsylvania, 19111.

Upon receipt of a new checklist, revision to an existing checklist or a page change, reflect this information in NavAir 01-700 by lining through the superseded information and writing in the superseding information.

A Rapid Action Change (RAC) program has been initiated for checklists and manuals listed in NavAir 01-700. A Type I Interim RAC is a message change. A Type II Formal RAC is a page change. The RAC methods are used for changes which affect safety and reliability. When the basic publications are reprinted, all changes are incorporated and new federal stock numbers are assigned.

BOMBS

The area should be thoroughly checked for any hazardous conditions prior to, during, and after all bomb loading. If a hazardous condition exists, it should be remedied at once. Ascertain that each member of the loading crew understands his position and functions in the loading procedure, and that safety precautions are strictly adhered to at all times. All loading crews should be restricted to the number of personnel required to do the job, and all personnel not needed should be well clear of the arming operation. Crowded conditions are a safety hazard and should never be allowed to exist.

All hoisting equipment should be checked for operation and serviceable condition. Hoists utilizing cables should be completely unreeled and the cables inspected for kinks or broken wires. The reservoir on hydraulic hoists should be checked and filled if necessary.

After these preparations and checks have been completed, actual hoisting of the stores can commence. Hoisting of stores is a precise operation and should be attempted only after a means of communication between members of the arming crew has been established (hand signals for up, down, hold, etc.). As loading crews work in close proximity to operating aircraft, especially aboard aircraft carriers, it is essential that these signals be well understood by all members of the loading crew. Talking between members of the crew should be restricted to essentials concerning the loading operations. After each store is hoisted and the rack or shackle has been latched, a safety pin with a red streamer is installed to safety the rack and prevent accidental release prior to takeoff.

Fuzing of conventional stores should be completed only after loading on the aircraft. (Refer to NavAir 11-5A-17 for specific instructions.)

When the aircraft is loaded (safety pins inserted and all switches are in the SAFE position), the pilot should be informed of the bomb load, the type and delay time of fuzes, the variation in drop sequence available, etc. Remember that you are part of a team, and a well-informed, properly supervised and coordinated team (from the assembly crews in the magazines to the delivery crews) is the shortest route to a successful mission.

Unloading

When dearming aircraft that are loaded with bombs, the aircraft are spotted in an authorized dearming area; the area is checked for any hazardous conditions, and all handling equipment is thoroughly inspected for defects prior to use. All safety precautions applicable to loading are also applicable to the unloading procedure. When unloading, use the unloading section of the Conventional Weapons Checklist. If any part of the fuze is missing, or any external evidence of arming is noted, notify EOD personnel immediately.

PRACTICE BOMBS

The preparation, handling, and loading most types of practice bombs generally require more careful consideration than conventional stores. This is because some practice bombs are armed at all times. Their more frequent use tends to make the handling crews more careless, consequently requiring closer supervision.

The preparation, handling, loading, and operation of practice bombs were thoroughly discussed in Aviation Ordnanceman 3 & 2, NavPers 10345-C.

ROCKETS

Currently there are two types of aircraft rockets in service use. They are the 2.75-inch (Mighty Mouse) and the 5.0-inch (Zuni) folding fin aircraft rockets (FFAR's). Detailed information on these rockets and their launcher is provided in AO 3 & 2, NavPers 10345-C, NavAir 11-85-5, and the specific NavAir manual on each launcher.

Aircraft rockets require a greater degree of care in handling than most other ordnance items due to the ease with which they may be ignited by electromagnetic radiation induced voltage and the ease with which the motor grain may crack when dropped. Each AO supervisor must insure that all personnel handling rockets (or any ordnance item) are qualified in accordance with OpNav Instruction 3571.3 (Series) and local instructions.

Arming a strike aircraft with either the 2.75-inch or 5.0-inch FFAR requires that the Conventional Weapons Checklist for the aircraft and launcher combination being used be rigidly followed. The checklist provides a step-by-step guide for readying the aircraft (configuration, release check, and stray voltage check) and loading the rocket launcher onto the bomb rack.

Aboard a carrier, the rocket launchers, loaded and ready to load onto the aircraft, are delivered to the squadron ordnancemen. The loaded launchers are loaded into the aircraft's bomb racks in a manner similar to bombs. Frangible fairings are fitted to the launchers after the launcher is loaded on the aircraft. Prior to making any electrical connection between the aircraft and the launcher, a stray voltage check must be performed. Each launcher is equipped with a safety device that electrically shorts the launcher firing circuit until the aircraft is ready for launch. The safety device on most launchers consists of a safety pin that opens the firing circuit and provides a ground to block any induced voltage until the pin is removed. The safety pin is not removed until the aircraft is ready for launching (on the catapult) and the area in front is clear. Specific procedures may vary from one ship to another, and the AO supervisor must be aware of the procedures on the ship on which he is operating.

The CVA/CVS NATOPS Manual also provides information on arming procedures for carriers. NavAir 16-1-529 should also be consulted for information on electromagnetic radiation hazards for rockets.

Procedures for arming/dearming aircraft rockets at a naval air station may differ from shipboard procedures only to the extent of the area where arming/dearming will be performed. Station instructions provide the necessary guidelines as to the exact location where aircraft may be positioned for arming or dearming. The arming/dearming area is determined by the surrounding terrain, buildings, flight lines, and danger from electromagnetic radiation.

AIRCRAFT GUNS

Aircraft guns mounted in jet aircraft are subjected to frequent and extreme temperature and humidity ranges, from +90° on the ground to -65° at altitude, in a matter of minutes. It is essential that guns be inspected, cleaned, and properly lubricated if they are to perform reliably. Guns in active use must be cleaned and relubricated after each day's firing or after 500 rounds, whichever occurs first. Ascertain that proper inspection, lubrication, and servicing have been performed prior to any loading of ammunition. The belted ammunition should be checked and relubricated if necessary (except for ammunition belted with Mk 6 links for use in Gun Pod Mk 4).

The AO supervising the arming of aircraft should establish the number of aircraft to be loaded, their bureau numbers or side numbers and the specific type loads (service or practice) from the daily flight schedule. He must also make preparations for the breakout and delivery of ammunition to the loading area. Aircraft should be loaded in order of their takeoff.

The quantity of ammunition moved to the loading area should be limited to that necessary to meet the requirements of the launching schedule. All ammunition removed from the ready service magazine must be protected from heat, dirt, grit, dust, etc., and prolonged exposures to direct sunlight. The senior AO should maintain close contact with all phases of the arming operation to emphasize safety precautions and to expedite any last minute changes in aircraft or mission. Safety is very important and must be constantly stressed throughout the arming and dearming operation. (The testing and servicing of aircraft gun systems and the loading and unloading of aircraft guns were discussed in Aviation Ordnanceman 3 & 2, NavPers 10345-C.)

MISSILES

Missile assembly, particularly that accomplished on shipboard, demands economy of time, personnel, and space. These requirements should be accomplished only by experienced crewmembers who can perform specific tasks in proper sequence, utilizing proper handling equipment while working effectively as a team.

Typical handling equipment includes sparkproof handtools (required for work with ordnance units), tool belts (often required but not always mandatory), special lock wrenches, and larger devices such as assembly jigs and dollies or loading skids. The jig serves to hold the heavy missile sections in place and properly alined for assembly. It also provides index markings which are used to insure the correct angular position of sections before being locked together. The dolly is used to transport the assembled missile to the ready service magazine or to the loading area.

An essential part of the missile supply "pipeline" aboard an aircraft carrier is the Ready Service Magazine (RSM). It serves as a source of supply for ready missiles which can be delivered within a few minutes after being ordered. In the RSM a number of missiles are kept fully assembled, or nearly so, except for a few minor adjustments and additions. As the supply of ready service missiles is depleted, assembly of other missiles is underway for delivery to the loading and arming crews.

Loading, Arming, and Dearming

The procedures authorized for loading, arming, and dearming guided missiles (as those employed with other types of ordnance) are based on considerations of safety and efficiency in handling and also on the characteristics of the specific weapon. Only the essential features of this phase of handling in air-launched missile operations can be considered in this discussion. These features, which are common to most missile systems, are indicated by examples given of standard preloading checks performed on the aircraft circuits, and by listing the basic processes and safety precautions practiced by loading and arming crews on aircraft carriers.

PRELOADING CHECKS.—Prior to loading, several checks must be made of the aircraft circuits that initiate the action of the missile ordnance units. These checks are made on the jettison circuits, on the firing circuits, and on the positions of several switches and circuit breakers in the cockpit.

When loading, unloading, arming, or dearming missiles on a radar type guidance system, circuit breakers and switches are normally set as follows:

Master arm switch	OFF
Arming control switch	OFF
Radar mode selector switch . .	OFF
Rocket circuit breaker	OUT
Jettison switches	OFF
Landing gear and slats indicator circuit breaker . .	IN

LOADING.—Aboard a carrier, missiles are loaded onto the aircraft on the flight deck (as are other items of aviation ordnance) unless operational conditions require it to be otherwise. Also, missile-loaded aircraft taken aboard are spotted on the flight deck and unloaded. Loading or unloading can be carried out on the hangar deck only when authorized by the commanding officer.

The basic procedures of loading and the precautions to be observed by the loading crew and other personnel during the operation are briefly described in the following list:

1. The aircraft is spotted, insuring that sufficient deck space is provided under the launchers for the loading equipment and maneuvering by the loading crew.
2. Before loading is started, all ordnance items should be checked to be sure that they are in the safe (unarmed) condition. A red pennant is attached to each missile safety device.
3. Loading crews wear special clothing: red helmets and jerseys, goggles, and hard-toed shoes. The goggles must be worn down over the eyes when aircraft are turning up.
4. When transporting missiles to the aircraft on skids or dollies, care must be taken to avoid subjecting them to hot jet exhaust or to intense radiation from nearby electronic equipment.
5. A minimum of three men is required to lift a missile from the skid to the aircraft launcher. Caution should be exercised to avoid injury from sharp surfaces or pointed projections. Fuze covers are left on until the last convenient moment before arming the missile.
6. If, during loading, a missile is dropped or severely jarred, it should be struck below for inspection.
7. After the loading operation is completed, the missiles are checked for proper physical security on the launchers. All launcher test points are checked for correct resistance readings, which indicate proper mating of the missile to the umbilical connector, and a red "LIVE ORDNANCE" tag is placed in the cockpit. The tag lists safe positions of switches and circuit breakers, and serves to give a warning to unauthorized personnel who may enter the cockpit.

ARMING.—Missiles loaded on carrier-based aircraft are armed only on the catapult unless permission to arm elsewhere on the flight deck is granted by the commanding officer. Safety in arming is achieved by cooperation of the pilot and the crewmembers in the use of distinct and well-understood hand signals.

NOTE: Hand signals are discussed in chapter 8 of this manual.

A signal from the pilot indicates that he is ready for the missiles to be armed and that all switches and circuit breakers are in the correct positions. The signal is relayed by the arming crew chief to a man under each wing. Upon completion of the arming, the two crewmembers give signals to the crew chief who relays them to the pilot and to the catapult officer.

Any persons in the surrounding area must be warned not to stand forward or aft of missiles during or after arming, since an armed missile must be regarded with the same respect as a loaded gun.

DEARMING AND UNLOADING.—When an aircraft returns aboard with missiles still on its launchers, the missiles must be dearmed and unloaded. It is necessary that the pilot advise the ship concerning the number of missiles being returned, whether live or dummy warheads are involved, and whether a firing attempt has been made. The dearming and ordnance disposal crews are then alerted accordingly.

Missiles still on the launchers at the completion of a flight fall into one of two classes: those which no attempt to fire has been made, and those which failed to leave the launchers after a normal firing attempt. Missiles of the second class are called "hangfires."

If a hangfire missile is smoking, the pilot jettisons it immediately. If no smoke is present, the pilot heads the aircraft in a suitable direction for a specified length of time. If no unsafe or unusual conditions are noted, the missile is then classified as a "misfire," and the pilot returns for a landing and for dearming and unloading of the missile.

The procedures used with the two classes of returned missiles differ principally as to the personnel involved. Dearming crews handle missiles returned after no firing attempt has been made. After the pilot has come to a stop forward on the flight deck and has signaled that all switches and circuit breakers are in the safe position, the missile crew begins dearming.

The rocket motor is made safe by installing the appropriate safety device. The pilot then taxies the aircraft to the parking spot where the crew completes the process of dearming. The jettison cartridges are removed, and the missiles are unloaded and struck below.

Procedures used with misfires require the services of an ordnance disposal crew. The ordnance disposal crew and the dearming crew meet the aircraft as it taxies forward on the flight deck. A visual inspection is made for signs of dangerous or unusual conditions. If any are noted, the aircraft is pointed in a clear direction, the engines are stopped, and the area cleared immediately of flight personnel. The ordnance disposal crew then assumes responsibility for handling the missiles.

If no dangerous conditions are found by the ordnance disposal crew, the dearming process proceeds and the missile or missiles are unloaded in the manner described above.

NUCLEAR WEAPONS

The handling and loading of nuclear weapons, though an important and demanding part of the AO's duties, is not discussed in detail due to the security classification of these weapons.

LOADING CREWS

Nuclear weapons are loaded by designated loading crews composed of the following minimums:

1. A nuclear weapons loading officer.
2. A nuclear weapons loading crew chief (normally an AO2 or above).
3. An assistant nuclear weapons loading crew chief.
4. Three additional personnel.

The loading crew must have a SECRET clearance and have completed the course at a Nuclear Weapons Loading School for the type and model aircraft and Mk and Mod weapon to be loaded. All personnel in a loading crew are designated in writing by the commanding officer of the ship, squadron, or station. In patrol squadrons, each flight crew is usually assigned as a nuclear weapons loading crew.

NUCLEAR WEAPONS LOADING SCHOOLS

The handling and loading of nuclear weapons is taught at Nuclear Weapons Loading Schools. A course is offered for each type and model aircraft and weapon combination. The schools present security information pertaining to nuclear weapons, training in use of flight circuit testers, wiring check of Aircraft Monitor and Control (AMAC) System, proper use of handling equipment, loading and unloading of nuclear weapons, and safety.

WIRING CHECKLISTS

A wiring check must be performed on the AMAC system prior to loading any nuclear weapon, utilizing the appropriate wiring checklist and a flight circuit tester. This check should be performed immediately prior to loading if possible. It must be performed within 24 hours prior to loading and after the last flight. The checklist includes material requirements, aircraft equipment installation, and applicable AAC's and AAB's. In using these checklists, all items and steps must be performed in sequence and no step may be omitted except as noted in the checklists.

LOADING CHECKLISTS

A SPECIAL WEAPONS LOADING CHECKLIST is published for each type and model aircraft capable of carrying and delivering nuclear weapons. These checklists are the same size as the wiring checklists (5 in. by 8 in.). They are mandatory for aircraft nuclear weapon system loading, and are directive in nature. They contain instructions to safely load, deliver, and unload nuclear weapons for Alert/Strike, Readiness/Maneuver, or Logistic Transport missions. The material requirements sections lists installation of aircraft equipment, appropriate loading and handling equipment, and applicable AAC's and AAB's. These checklists are consumable—one for each mission.

SPECIAL STORES SUPPLEMENTAL MANUAL

This manual is a section of the Maintenance Instructions Manual and is published for each type and model aircraft capable of carrying and delivering a nuclear weapon. This manual is classified CONFIDENTIAL and contains introduction, description, loading instructions, flight crew operating instructions, unloading instructions, maintenance instructions, and Illustrated Parts Breakdown pertaining to nuclear weapons and related equipment. It is intended to be used with the wiring and loading checklists. Where information in the Special Stores Supplemental Manual differs from that in the loading check list, the information in the checklist will take precedence.

SECURITY

In any operation involving nuclear weapons, strict adherence to all directives and regulations concerning security is mandatory. All persons whose duties require handling of nuclear weapons must be throughly indoctrinated in security procedures as part of their daily duties. Security should be stressed in all training programs.

By observation or rumor, unauthorized persons may become aware of a unit's nuclear weapons capability. Loose talk by these persons is the principal hazard in maintaining the desired degree of security. All persons in a supervisory capacity should take appropriate steps to inform their men of the seriousness of unguarded talk concerning classified information whether based on fact or imagination.

Nuclear weapons shipping containers are normally unclassified, as are the visible size and shape of externally carried nuclear weapons if the weapon is not identified as a nuclear weapon. However, details concerning the nature and purpose of the object, or its size and shape are classified and must be protected.

Physical security of nuclear weapons is not discussed here. It is extensively covered in Special Weapons Ordnance Publications (SWOP) and the following OPNAV Instructions:

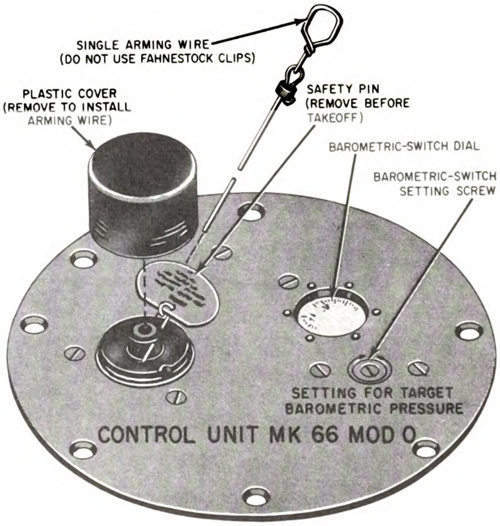
5510.45	(Series)
05510.25	(Series)
05510.26	(Series)
011012.1	(Series)

UNDERWATER WEAPONS

The preparation of underwater weapons (less depth charges) is a function of either the Mobile Mine Assembly Team (MOMAT) for mines, or the Advanced Undersea Weapon (AUW) shop for torpedoes. Both types of these weapons are normally delivered to the ordnance loading crew fully assembled, operationally checked, and ready for loading on the aircraft.

AIRCRAFT LAID MINES

The ordnanceman assigned to a mine loading team should have a through knowledge of the type mine to be loaded, including proper parapak positioning, static line attachment, and arming wire installation. Mines which are equipped with atmospheric parapak control units must have the barometric switch on the control unit set to the atmospheric pressure expected at the target. If this is not known, the unit's dial should be set at 30. All control units in the load should be set the same. (See fig. 7-1.)

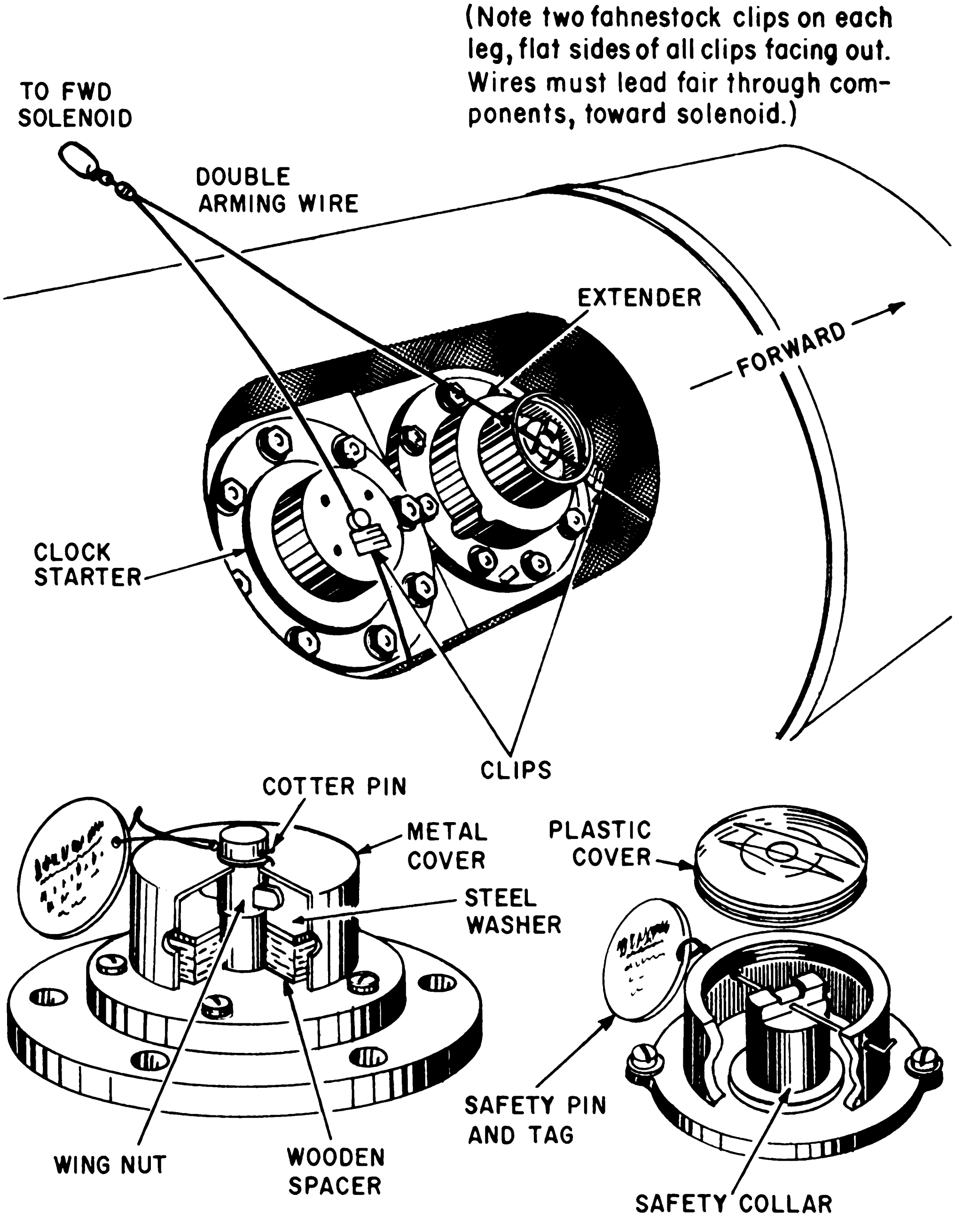


AO. 545

Figure 7-1.—Parachute Control Unit Mk 66.

The loading procedure for aircraft laid mines is similar to that for conventional aircraft bombs, except for installation of arming wires in the clock starter and extender. These units are usually located in a well in the side of the mine in a thwartship position. (See fig. 7-2.)

Liaison should be established with the MOMAT before a mining operation to insure that the mines will arrive in the proper configuration; fins and parapaks in the proper position and suspension lugs correctly spaced for the bomb racks in use. Mines should be numbered so as to be loaded in proper sequence for positioning in the mine field. Procedures for loading aircraft mines are provided in loading checklists in the NavAir 01 series. Another publication which may be useful is Installation of U.S. Mines in Naval Aircraft, NavAir 11-80-501. A listing of checklists may be found in NavSup 2002. Another source of information on mines is the "Troubleshooter," an official publication published by the Naval Mine Engineering Facility, Yorktown, Va.



(Note two fahnestock clips on each leg, flat sides of all clips facing out. Wires must lead fair through components, toward solenoid.)

Remove metal cover, wing nut, steel washer, and wooden spacer. Replace wing nut loosely; replace metal cover tightly. Turn nut so that hole for arming wire is just barely exposed; then pass arming wire through hole.

Remove plastic cover and pin; leave safety collar in place. Pass arming wire through extender body and piston-rod hole in place of safetypin.

AO.546

Figure 7-2.–Arming wire installations in clock starter and extender.

During any mine loading or unloading, at least one qualified Mineman should be standing by in the loading area to assist in the event an arming wire gets pulled, a parapak gets blown, or any other occasion which requires detailed technical information about the mines.

AIRCRAFT TORPEDOES

Torpedoes should be delivered to the loading area by the AUW shop personnel in a ready-to-load condition. Custody of the torpodoes is usually signed for by the senior man. They must be inspected for proper type and spacing of suspension bands with release wires installed, safety pins in warhead exploder or exercise head, safety pins in salt water scoop or battery and starter switch, and correct type and installation of air stabilizer.

If a cable type hoist is to be used, a hoisting band of the Aero 61A type is preferred to the chain or cable type. Care must be taken during all operations not to damage the transducer in the nose of the torpedo.

Torpedo Firing Report

The Torpedo Firing Report (BuWeps 8510/3) should accompany each torpedo to the loading area. It is a five-page report of the NCR (no carbon required) type, is divided into three parts, and is CONFIDENTIAL when filled in. Instructions for completing the report are on the back side of each page.

Part one is filled in by the preparing activity and lists MK and Mod and serial number of the warhead or exercise head, battery, afterbody, suspension bands, and air stabilizer. The initial search depth (ISD) and floor settings are also listed. Part two is filled in by the aircrew of the firing activity and must be signed by the commanding officer of the firing activity. If an exercise head was installed and the torpedo was recovered, page five is retained by the firing activity as an interim record; the first four pages are forwarded to the post run activity which fills in part three and returns page three to the firing activity. It is retained as a permanent record. If the torpedo is lost or is a war shot, the preparing activity forwards the torpedo logbook to the firing activity. The logbook and the first four pages of the torpedo firing report are forwarded to the Torpedo Office, Keyport, Washington or Newport, Rhode Island by registered mail. OP 1207 U.S. Navy Aircraft Torpedoes, Accessories, and Trajectory Data may be consulted for additional information on torpedo loading.

SUPPLEMENTARY STORES

The modern combatant aircraft is required to perform a variety of missions in addition to its primary mission. In order to do this, various stores not considered to be ordnance are carried on bomb racks. These include chaff dispensers, fuel tanks and inflight refueling packages, communication/navigation packages, and aerial film delivery containers.

FUEL TANKS

Suspension of fuel tanks, externally or in bomb bays, is the responsibility of the AO. Prior to hanging any fuel tank (on or in an aircraft), a continuity check should be made of the release circuit, and racks or shackles should be checked for proper operation. Empty fuel tanks may be loaded on aircraft by hand or by use of a portable bomb hoist. In some installations, fuel lines and/or connections must be made prior to latching of the racks or shackles and prior to hoisting the tank to the full up position. This is especially true in bomb bay installations where space is limited.

The AO and AD usually perform these operations as a team. The AD is responsible for the connection of fuel hoses, pressurizing fittings, and electrical leads. All tanks loaded on or unloaded from aircraft must be empty, except on rare occasions in the case of jellied gasoline (napalm). This is sometimes mixed in droppable tanks to be loaded later due to the time requirements for the jell process and the time required to mix sufficient quantities for scheduled flights. Fire bombs and napalm mixing procedures are discussed in Aviation Ordnanceman 3 & 2, NavPers 10345-C.

In-Flight Refueling Store

The in-flight refueling store (buddy pack) is used to convert light attack aircraft into tankers. It weighs approximately 700 pounds empty and 2,700 pounds full, and has a 30-inch suspension. The areas of responsibilities are the same as for droppable fuel tanks. This store employs a cartridge actuated device to sever the drogue if it will not retract. The system contains a control panel which may be installed in place of a weapon control panel not needed for the flight.

A special dolly is used for ground handling and loading and unloading the store. The dolly has four hoist winches which raise or lower the store on two nylon straps through a strap reel and worm gear. The hoists may be operated independently to raise or lower either end of the store or to rotate it as much as 15° about its longitudinal axis. Brakes are provided for each wheel and the wheels may be unlocked and swiveled.

COMMUNICATION AND NAVIGATION PACKAGES

Communication and navigation packages (NAVPAC's), as with chaff dispensers, are the responsibility of the electronics branch personnel. They are specialized stores carried on the centerline station of some light jet aircraft. The use of NAVPAC's is limited as newer aircraft carry all necessary navigation equipment internally. The AO, however, should have sufficient knowledge to permit safe handling of this somewhat delicate electronic equipment. For most externally carried stores of this type a breakaway plug is used on the electrical cable to facilitate jettisoning of the store without damage to the aircraft. For detailed technical information on each specific installation refer to the appropriate Maintenance Instructions Manual.

HANDLING EQUIPMENT

Many types of handling equipment are available to reduce manpower and time required in preparing for a tactical air strike. The most frequently employed are weapons skids. They are mobile, nonpowered vehicles for transporting air weapons and components. Certain skids, however, may be towed by powered equipment; others have attachments for being lifted and transported by powered equipment. As many as seven different types of weapons skids are available for use on a carrier. Some are designated to handle specific weapons; some, when fitted with adapters, can accommodate a large variety of weapons loads; and others have been designed for certain weight or size weapons. Two skids, the Aero 12C bomb skid and the Aero 21A weapons skid, have evolved as the most versatile skids because of the variety of weapons and weapons components they are equipped to handle.

The AO supervisor must be familiar with the various types, capacities, and configurations of handling equipment so that he can prepare a workable plan for weapons movement. Normally, the AO supervisor does not get involved with the actual task of skid or truck configurations, but he must be able to recognize the proper or improper configuration at the earliest possible moment to prevent a delay in preparing for the strike. He must also be able to provide instructions as to the proper methods of configuration, maintenance, and quality assurance inspections.

Additional information on the various types of handling equipment can be found in NavOrd OP 2173 (3 volumes), NavAir 00-120 series manuals, and AO 3 & 2, NavPers 10345-C.

ARMING AND DEARMING AREAS

Arming and dearming areas are utilized to provide a safe working area for arming and safing air-launched weapons. Certain types of weapons require that they be onloaded or offloaded in these areas also.

SHIPBOARD

Aboard a carrier the arming and dearming areas are designated in the ship's instructions. These areas must comply with the requirements stated in the CVA/CVS NATOPS Manual for certain ordnance items. Each type of ordnance presents a different hazard, and the arming and safing of these items must take this into consideration when arming and dearming areas are designated.

Forward firing weapons (aircraft guns, rockets, and guided missiles) require that the area in front of the aircraft be clear and remain clear at all times while the weapon is in an armed condition. Usually these weapons are not armed until the aircraft is on the catapult ready for launch. These items are safed immediately after recovery, prior to the aircraft being taxied forward into the pack. These items must also be offloaded prior to the plane being taken to the hanger deck, unless the commanding officer grants permission due to operational commitments.

Freefall weapons (bombs) may be loaded onto the aircraft bomb rack on the hangar or flight deck, but no electrical connection may be made between the weapon and aircraft, no mechanical fuzes may be installed, and no ejector cartridges may be installed in the ejector racks while the aircraft is still on the hangar deck. The bomb rack safety pin should be installed immediately after the weapon is locked into the bomb rack and not removed until the aircraft is manned, turned up, and ready to taxi.

A arming/dearming crew supervisor must be present during all arming and/or safing operations. He acts as a safety monitor and coordinator and must be familiar with the arming and safing signals is listed in the CVA/CVS NATOPS Manual.

SHORE STATIONS

Arming and/or dearming procedures ashore differ from a carrier only to the extent that all arming/dearming procedures are normally performed in designated areas at the end of the runway. These areas are designated in the station instructions and all AO personnel must be familiar with them. RADHAZ requirements vary from station to station, and these must also be a part of the AO's knowledge.

SAFETY PRECAUTIONS

In any discussion of safety precautions, it is difficult to cover every situation that may arise and which, unless properly handled, may have serious results. An attempt must therefore be made to grasp the ideas upon which the precautions are based in order that unsafe conditions can be recognized and corrected and, further, that suitable action may be taken instinctively when the unexpected occurs. In addition, the success of a safety program requires constant vigilance by all responsible persons in the following major areas: personal conduct, regulation and procedures, and equipment condition.

Carelessness, noncompliance with proper procedures, lack of alertness, disorganized haste, ignorance, and overconfidence are probably the most common causes of accidents. Proper instructions and supervision will reduce these problem areas to a minimum.

LOADING

Prior to loading any weapon or store, the AO should insure that it is authorized by the NATOPS Manual for that aircraft and the particular station to be loaded. All hoisting equipment must be inspected for safe operating condition and rejected if found to be unsafe. Personnel not required for the loading operation should stand clear of the area.

BOMBS

Bomb type ammunition is not only hazardous because of the deterioration or instability of its explosive composition, but also dangerous when handled or moved about. All bomb type ammunition should be handled very carefully because rubbing, bumping, dragging, or dropping a round could cause it to detonate and possibly cause all other nearby rounds to detonate. Always store bombs in magazines separate from magazines containing fuzes, boosters, igniters, pyrotechnics, etc. When transporting bombs, insure that chain binders or straps are snugged tight and safety chains are fastened to each bomb trailer.

Avoid using force when installing bomb fuzes. Keep the fuze cavities clean. When necessary, use nonmetaclic material to remove any foreign matter from the cavities. Fuze cavity threads should be inspected periodically for rust; if necessary, clean and relubricate.

Bomb clusters are more likely to be damaged by rough handling than individual bombs, and must be handled with greater care because they contain fuzed bombs.

Practice bombs with signals installed are extremely dangerous. In this condition these bombs are always armed and, if dropped, there is a possibility of an explosion. In some cases the bomb body is shattered, resulting in damage to aircraft or equipment, or serious injury to personnel.

MINES AND TORPEDOES

In most cases the safety precautions that apply to bombs also apply to mines and torpedoes. However, additional precautions should be observed when handling the latter.

During the loading operation never lift, guide, steady, or stand behind a weapon equipped with a parapak; keep well clear of the propellers and guidance control surfaces of self-propelled weapons.

Use extreme care when installing arming wires in clock starters, extenders, and exploder mechanisms. (NOTE: Personnel of the TM or MN rating are responsible for the assembly and storing of underseas weapons.)

Remember that no mine should be jettisoned in water less than 800 feet deep.

ROCKETS

Improper handling of rockets could result in the fracture of the propellent grain, causing erratic firing or possibly exploding in close proxity of the launching aircraft.

An assembled rocket accidentially fired will assume the direction in which it is pointed, damaging, destroying, or killing anything or anyone in its path. Avoid standing behind an assembled rocket as an accidentally fired round expels a blast of burning gas of high temperature and velocity rearward which is capable of injuring or killing anyone in close proximity.

A rocket exposed to temperature outside the range marked on the motor should not be fired; refer to NavAir 11-85-5 for action to be taken.

If a fuzed rocket warhead is dropped more than 5 feet, it should not be used but put aside for disposition in accordance with pertinent instructions.

While assembling rockets, maintain a 5-foot distance (or more) from radio, radar, or other high voltage apparatus.

MISSILES

In view of the number of safety precautions that have been formulated for each type of missile, it is impossible to discuss them all here. However, some of the general safety precautions are as follows:

1. All missile handling must be carried out in accordance with approved local safety regulations in force on shipboard, at depots, or wherever the work is accomplished. Detailed precautions must be observed, and specific instructions must be followed with each type of guided missile. These are given in the manual issued for each particular type of missile.
2. Work areas must be kept clear of obstructions, loose cables, hoses, and any unneeded equipment during missile assembly and testing. Only those persons engaged in the work in progress should be permitted in the work area or in the vicinity of the missile.
3. Only authorized handling equipment should be used with any missile, or with any missile section, component, or related parts, including shipping crates and containers.
4. Care should be taken to see that all electrical equipment used in missile handling operations is adequately shielded and grounded. Also, care should be taken to avoid injury from sharp edges which are often present on nose assemblies, wings, and fins. After assembly, all sharp edges which are dangerous should be covered with guards.
5. Tools used for uncrating missile components and those used during assembly must be of the type specified in the missile manual. Never attempt to force any unit; if it does not fit or function properly, determine the cause and correct it before proceeding.
6. Before connecting igniters in missile motors, check the firing leads for stray or induced voltages and for static charge.
7. Before handling any piece of ordnance material, inspect the safety device to be sure that it is in the SAFE position. If not, the unit must be made safe by experienced personnel before further work is performed.
8. The wing servo units in many missiles are supplied with primary power by means of an accumulator charged from gas bottles, or cylinders, containing compressed air or nitrogen. The high pressures used in those units make it necessary that extreme caution be exercised by personnel charging the accumulators and gas bottles or handling the containers in which the gases are stowed.
9. When testing for leaks in a gas container, use soapy water.
10. When cleaning hydraulic units, use only the cleaning solvents or other materials specified in the pertinent missile publication.
11. Keep the hands and other parts of the body well clear of exhaust streams when working with test equipment employing high-pneumatic pressures.
12. When any hydrualic unit is disassembled for inspection or repair, be sure that the workbench is thoroughly cleaned of dirt and metal filings.
13. Missile ordnance materials, which include rocket motors, igniters fuzes, warheads, and in some cases, boosters, or auxiliary rockets are potentially dangerous; any particular unit must be handled in accordance with the specific procedures authorized in the appropriate publication.

If a dangerous situation arises that is not covered by a safety precaution, NavAirSysCom should be notified.

PYROTECHNICS

Photoflash cartridges are electrically initiated and are NOT RADHAZ safe. The shunt clip on the electric primer must remain in place until just prior to loading into the ejector (loading must be in RadHaz free environment). All cartridges manufactured in 1955 and later must have the word "X-rayed" stamped on the cartridge case.

ARMING AND DEARMING AREAS

The AO in charge of arming and dearming crews must be especially alert to detect and rectify any unsafe practices while arming and dearming aircraft. At these times the aircraft's engines are usually operating and the danger of jet intakes and exhausts is present. The wearing of sound attenuators is mandatory and a well understood set of hand signals between the pilot, crew leader, and arming crew is necessary. All safety pins, shorting clips, stripped links, or other loose articles must be removed from the areas to prevent them from being sucked into jet intakes. When aircraft have armed rockets or guns, every effort should be made to keep them headed in a safe direction.

UNLOADING

No relaxation of safety precautions is permitted during unloading operations. Safety pins must be inserted in all loaded stations before unloading any station. Bomb ejector and separation cartridges must be removed and no electrical power applied during unloading. Fuze safety pins are to be installed before removing arming wires, and the fuzes removed before lowering the weapon. NOTE: If any fuze or arming component is missing, loose or damaged, do not unload until it is inspected by EOD personnel.

A partial listing of publications containing safety precatuions with which the senior AO should be familiar and have readily available are as follows:

OP 1014 Ordnance Safety Precautions, Their Origin and Necessity.

OP 3347 United States Navy Ordnance Safety Precautions.

NavAir 11-85-5 Aircraft Rockets.

NavAir 11-15-7 Pyrotechnics and Miscellaneous Explosives Items.

NavAir 11-5A-17 Aircraft Bombs, Fuzes, and Associated Components.

CVA/CVS NATOPS Manual.

In addition to the above listed publications numerous other OP's and equipment manuals and instructions contain safety precautions pertaining to specific equipments.

CHAPTER 8

SHIPBOARD ORDNANCE

Aviation Ordnancemen assigned to an attack aircraft carrier provide the weapons for the ship's offensive power and weapons for air-to-air defense. Combat aircraft are useless without the weapons to provide the punch necessary to kill the intended target. Magazines, elevators, handling equipment, and explosives are the primary concern of the AO assigned to a carrier.

ORGANIZATION

The organization of a typical weapons department aboard a carrier should be understood by each individual in the department. Knowledge of the responsibilities of related divisions will aid the individual in jobs that are closely related.

WEAPONS DEPARTMENT

The weapons department officer is responsible, under the executive officer and commanding officer, for the supervision and direction of the employment and maintenance of the armament and ordnance equipment of the ship. An AO assigned to the weapons department would normally be assigned to either the G or the GM division where he would assist the department in procurement, handling, stowage, and issue of ship and aircraft conventional ammunition, pyrotechnics, and guided missiles.

The typical weapons department is divided into six divisions. The divisions and their responsibilities are as shown in table 8-1.

Ordnance Group Officer

The ordnance officer is the ordnance group officer for the department. All divisions of the weapons department (except W and Seventh) are under his direction. The ordnance officer is responsible, under the weapons officer, for directing the ordnance divisions (G, GM, Fifth, and Fox), in the operation, maintenance, and repair of the ship's fire control and gunnery systems and associated equipment, the operation of the ship's armory and magazines, procurement, stowage, assembly, maintenance, and issue of aircraft munitions (except special weapons), and the upkeep of assigned space.

G Division

The G division is the largest division in the weapons department. A typical G division organization is presented in figure 8-1.

The ordnance handling officer is the division officer; he is assisted by the G division junior officer in matters of personnel and administration. The air gunner is responsible to the ordnance handling officer and the ordnance officer in evolutions of ordnance handling on the flight and hangar decks. The ship's gunner normally is not assigned to the G division, but he works closely in matters dealing with magazines. Division personnel are divided into several crews to perform effectively the mission of the division and departments. Normally, the crews are divided as indicated in the following paragraphs.

Flight deck crew–The flight deck crew is responsible, under the air gunner and ordnance handling officer, for the issue, receiving, and expenditure report (daily) of all conventional aviation ordnance handled on the flight deck.

Bomb elevator crew–The bomb elevator crew is responsible, under the air gunner and ordnance handling officer, for the safe operation, maintenance, and PMS of all bomb elevators aboard.

Forward assembly crew–The forward assembly crew is responsible, under the ordnance handling officer, for the breakout, assembly, and movement of ammunition in the forward assembly area of the ship. (Normally this area is located on the forward messdecks.)

Table 8-1.—Typical weapons department organization.

Division	Responsibility
G	Procure, issue, stow, and assemble conventional ammunition, pyrotechnics, and chemical ammunition. Maintain records and reports associated with the Ammunition Stock Recording System (ASRS). Maintain magazines (for stowage of aviation ordnance). Maintain ordnance handling equipment and bomb elevators. Maintain the ship's armory. The armory is a responsibility of the Fifth division on some carriers. Maintain assigned spaces and squadron armories (squadron armories are assigned to the Carrier Air Wing when embarked).
GM	Procure (through the G division), stow, assemble, test, and issue guided missiles. Maintain missile records and reports. Maintain divisional spaces.
W	Procure, stow, assemble, test, and issue special weapons. Maintain records and reports associated with special weapons. Maintain divisional spaces.
FIFTH	Procure (through the G division) and stow ammunition for the ship's guns. Maintain magazines (for ship's gun ammunition), ship's guns, and divisional spaces. Prepare and maintain records and reports associated with the ship's guns.
FOX	Maintain the ship's fire control radar directors. Prepare and maintain associated records and reports. Maintain divisional spaces.
SEVENTH	The Marines are responsible for the internal and external security of the ship. Supervise the small arms firing for watch standers. Maintain and control the ship's brig.

Office/CADS crew–The G division office crew is responsible, under the G division administrative assistant, for preparing, maintaining, and control of all technical directives, training, correspondence, and MDCS (Maintenance Data Collection System) reports. The CADS (Conventional Ammunition Distribution System) crew is responsible, under the ordnance officer and ordnance handling officer, for preparing ammunition requests, special and timely reports, maintaining a composite daily expenditure report, maintaining an accurate inventory (by lot and type of ammunition) of all ship's gun ammunition and aviation ordnance aboard at all times. Also, the CADS crew prepares message traffic as required in matters of ammunition transactions.

After assembly crew–The after (AFT) assembly crew performs the same functions as the forward assembly crew except in a different location. The AFT assembly crew normally works on the aft messdecks.

Hoist repair crew–The hoist repair crew (not used on all carriers) is responsible, under the ordnance handling officer, for the installation, PMS, and maintenance of all pneumatic, electrical, and manual hoists used in the movement or assembly or ammunition.

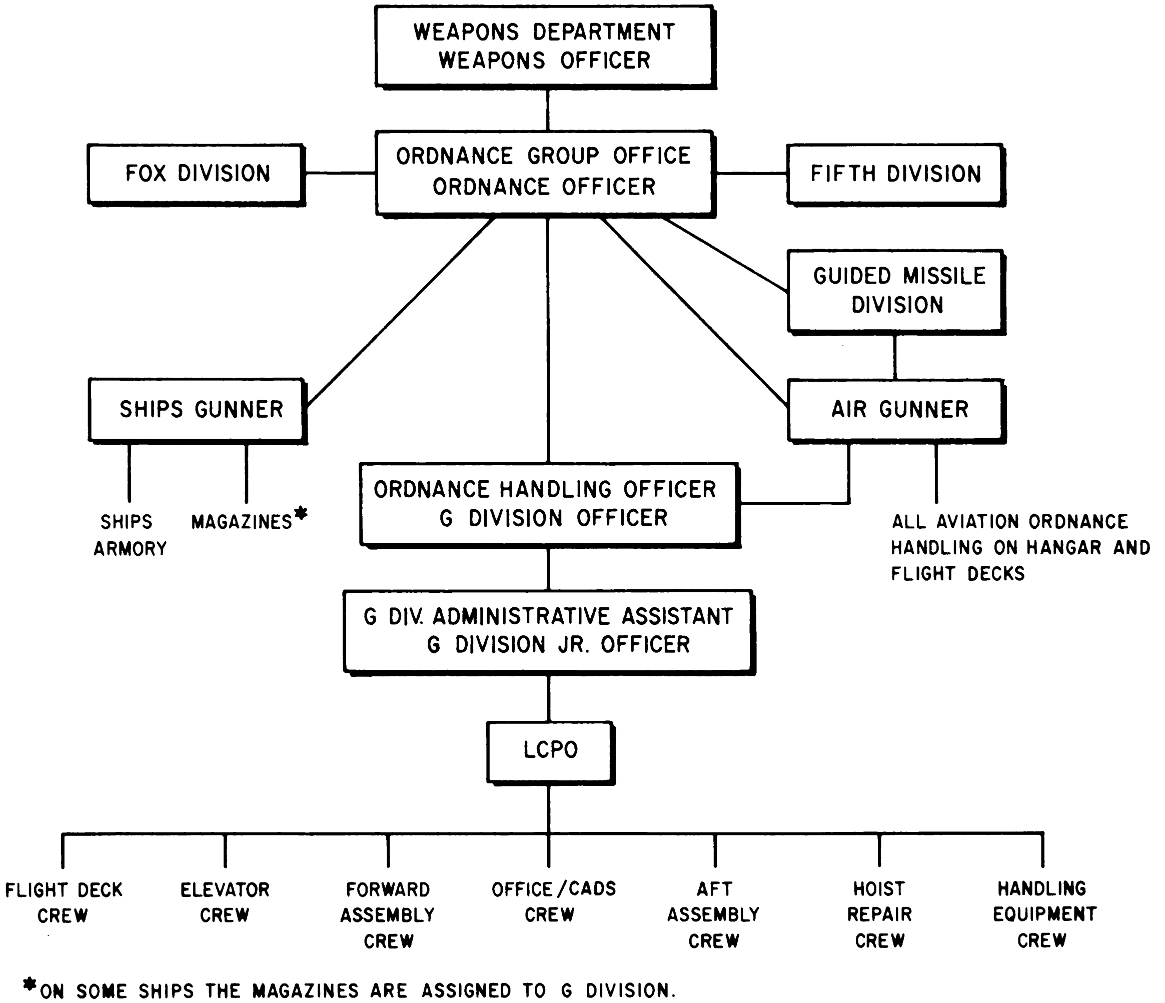
Handling equipment crew–The handling equipment crew is responsible, under the ordnance handling officer, for the inventory, repair, PMS, and configuration of all assigned ordnance handling equipment.

GM Division

The guided missile division (GM) is responsible, under the guided missile officer and ordnance officer, for the procurement (with the G division ASRS crew), stowage, assembly, test, and issue of all guided missiles aboard used for air-to-air or air-to-surface operations. Aircraft launched target missiles are also under the cognizance of the GM division.

Armory and Magazines

The ship's armory is responsible, under the ship's gunner, for the security and maintenance of the ship's small arms and line throwing guns.



AO. 547

Figure 8-1.—Typical G division organization.

The ship's magazines are assigned to the ship's gunner aboard some ships; while aboard other ships, the magazines used to stow aviation ordnance is a responsibility of the G division. The armory and magazine crews consist of personnel of the Gunner's Mate and Aviation Ordnance rates.

AIRCRAFT INTERMEDIATE MAINTENANCE DEPARTMENT

The mission of the Aircraft Intermediate Maintenance Department (AIMD) is to provide maintenance, support facilities, and technical assistance to the Carrier Air Wing (CAW) within the total resources of the ship. The department has personnel of all aviation ratings assigned to maintain the various components of the different types of aircraft aboard. Aviation Ordnancemen are also a part of this department, operating the Multiple Ejector Racks (MER) and Triple Ejector Racks (TER) shop and the gun pod shop.

MER/TER Shop

To maintain the MER/TER racks in an operating condition, the MER/TER shop checks the racks prior to custodial issue of the racks to the weapons department (G division) personnel for loading. When an aircraft returns from a mission, the racks that are to be preloaded are removed from the aircraft by squadron ordnancemen and delivered to the MER/TER shop to be checked, cleaned, and, if necessary, repaired before being returned to the G division for reloading. If the racks have been used once during the day they must be checked that night; if they have been used five times during the day, they must be checked prior to the sixth flight; if they have been unused for 30 days, they must be checked before reissue.

Gun Pod Shop

The gun pod shop is another AIMD facility manned by AO personnel for the maintenance of the Mk 4 gun pod, which houses a rapid fire, dual-barrel, 20-mm Mk 11 gun.

When an aircraft returns from a mission, the gun is removed from the aircraft by squadron ordnancemen and returned to the gun pod shop. If jammed, Explosive Ordnance Disposal (EOD) personnel clear the gun before it is removed from the aircraft. IF EOD requires mechanical assistance, AIMD will clear the gun under EOD supervision. Once delivered to the shop, cleaning, testing, and repairing procedures are begun, and the weapon is finally returned to the G division for reloading/stowage.

Support Equipment

On some carriers the proper performance of all yellow gear is a responsibility of AMID. Forklift trucks, skids, adapters, hoists, and all mechanical support equipment of the G division are included. Other carriers continue to maintain the above equipment as a part of the G division.

MAGAZINES

The term magazine, as used in this manual, means any compartment, space, or locker on board ship, which is used or intended to be used for the stowage of explosives or ammunition of any kind.

A hundred years ago a ship's magazine was primarily a place to stow black powder. Today, we have many complex weapons that require separate stowage from any other weapon. The AO assigned to a carrier should know the various types of magazines, inspections, sprinkler systems, and stowage compatibility of the different weapons carried aboard.

TYPES OF MAGAZINES

There are five types of magazines in use today aboard carriers. They are primary, ready service, missile, biological and chemical, and lockers. Primary and missile magazines are designed to accomodate a vessel's complete allowance of ammunition for peacetime operation. The combined capacities of primary, missile, and ready-service magazines are normally designed to properly stow the allowance for war or other emergencies.

The AO supervisor assigned to a carrier should know the types and the permissible stowage of the weapons carried aboard. The supervisor works with the ordnance handling officer and ordnance officer in preparing plans for evolutions involving rearming and movement of explosives. 'Figure 8-2 (A) and 8-2 (B) show typical CVA magazine arrangements.

Primary Magazine

Primary magazines are designed ammunition stowage spaces, generally located below the main deck and, insofar as practicable, below the waterline. They are adequately equipped with thermal insulation, ventilation, and sprinkling systems, and can be securely locked. They are designed to stow a vessel's complete allowance of ammunition as prescribed in allowance lists which are compiled in accordance with the original ship specifications.

Missile Magazines

With the introduction of guided missiles aboard ship, certain traditional naval requirements pertaining to magazines had to be modified; the more important modifications are as follows:

1. Generally, surface-launched missile magazines are located above the waterline. Also, air-launched missile magazines in aircraft carriers are generally located below the waterline and within the armor box. Air-launched missile ready-service magazines may be located above the waterline, or within the armor box.

2. Missile magazines contain power-operated handling equipment (electrical, hydraulic, pneumatic).

3. In order to provide adequate and continuous surveillance in magazines containing certain missiles, and to provide assurance that

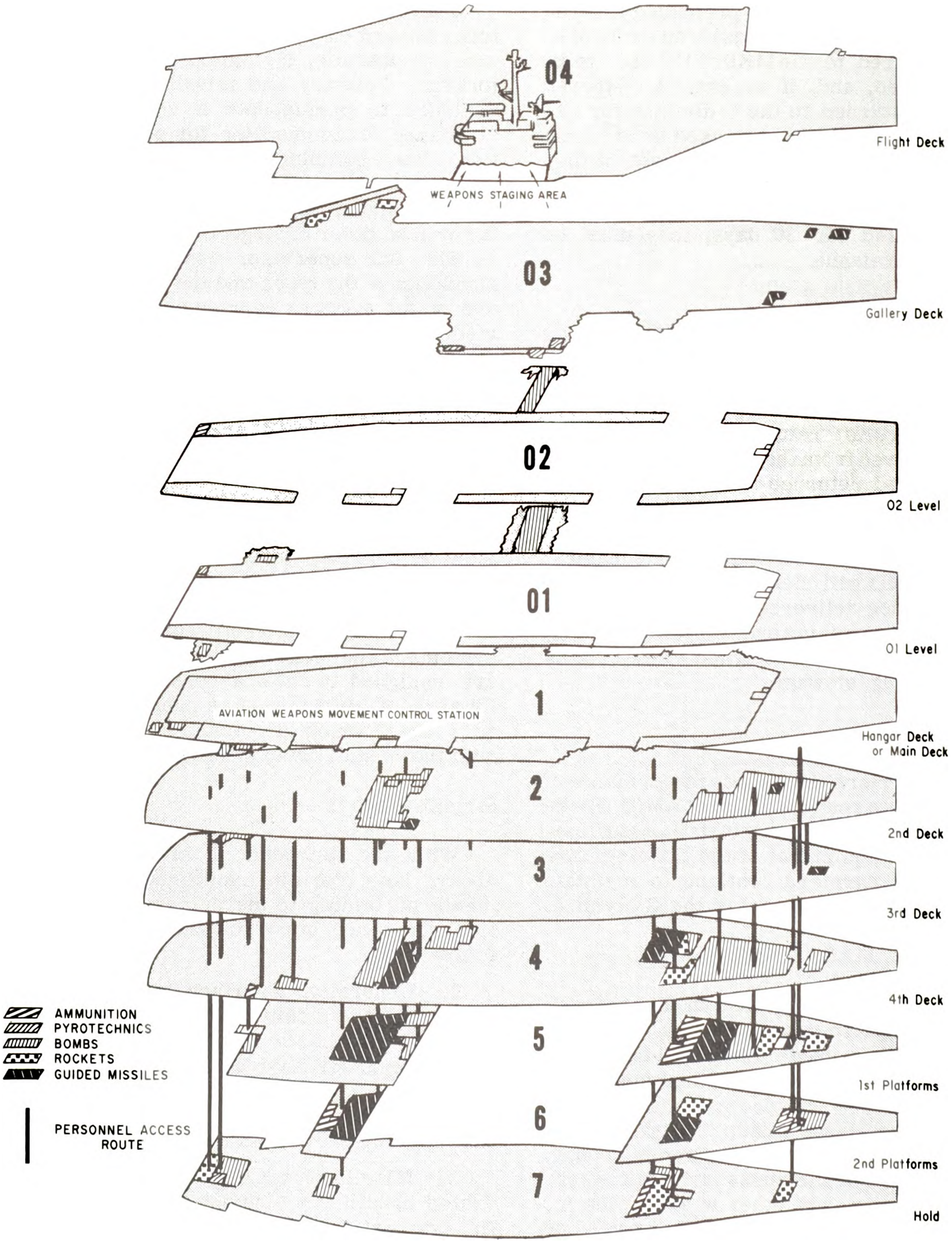


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Figure 8-2.—Typical CVA primary magazine locations.

a specific hazard is not actively present, these magazines are equipped with specialized detection equipment.

4. Although provisions for emergency venting is provided for most magazines, special care is taken with the venting system for missile magazines to ensure that magazine pressures will not build up to a dangerous level, should a missile motor be ignited.

5. Additional firefighting and fire extinguishing equipment is frequently provided for missile magazines. This equipment may consist of a CO_2 system, a foam system, a water injection system, sprinkling system, or a combination of these systems.

6. Restraining gear will prevent movement of an inadvertently ignited rocket motor.

Ready-Service Magazines

Ready-service magazines are those designated spaces which are physically convenient to the weapon or designated area to be served and which provide permanent stowage for part of the ammunition allowance. They are normally equipped with thermal insulation, ventilation, and ammunition sprinkling systems, and are secured by locking.

1. Ready-service stowage designates those ammunition stowage facilities in the immediate vicinity of the weapon or aircraft arming area.

2. Certain specially designated magazines, located in the armor box of aircraft carriers, are used for stowage of complete, assembled rounds of weapons and/or targets. These are ready-service magazines.

Biological and Chemical (B/C) Magazines

B/C ammunition, classified as lethal or incapacitating, will not be carried aboard ship unless specifically authorized by higher authority. If authorized, specific detailed instructions will be provided by NavOrdSysCom, and trained personnel will be required.

Specific spaces aboard ship may be designated by NavOrdSysCom as B/C magazines. Decks and bulkheads of B/C magazines should be coated with impermeable material. The magazine should have provision for sampling the atmosphere of the magazine from another compartment. Facilities for personnel decontamination and gross decontamination should be provided near the magazine.

Lockers

Certain compartments or lockers are designed and provided to permit stowage of special types of ammunition and ammunition components (such as detonators, pyrotechnics, chemicals, etc.). These are frequently located on the weather deck and are as convenient to the weapons or spaces to be served as practicable. They may or may not be sprinkler equipped, but are provided with locking facilities.

DESIGNATION OF MAGAZINES

Magazines or ammunition stowage spaces afloat are designated with particular reference to the purpose intended. Insofar as practicable, magazines are designed to hold a single type of ammunition.

Single-Purpose Magazines

The following designations are given for magazines whenever a single-purpose stowage is practicable:

1. Powder and rocket motor magazines.
2. Fixed ammunition magazines.
3. Small arms magazines.
4. Missile magazines.
5. Warhead lockers or magazines.
6. Aircraft bomb magazines.
7. Projectile and rocket head magazines.
8. Fuze magazines.
9. Detonator lockers.
10. Pyrotechnic magazines or lockers.
11. Ready-service ammunition rooms, boxes, racks, or lockers.
12. Biological and chemical (B/C) magazines.

While stowage of a single type of ammunition in individual magazines is desirable, it is not always possible. NavOrdSysCom has therefore authorized certain mixed stowages in magazines which nevertheless retain single-purpose designations.

Multipurpose Magazines

Where space limitations are such that stowage in accordance with existing instructions is impossible, and where the mission requires carrying various types of ammunition, stowage of more than one type in one magazine is an acceptable hazard and authorization is at the discretion of the operational commander. Such mixed stowage does not include B/C weapons and/or pyrotechnics which have been removed from containers, or fuzes and detonators which are not integral parts of, or assembled within, the ammunition. Where mixed stowage of ammunition is necessary, precautions must be taken to insure that the various types of ammunition are segregated within the magazine and that each type is suitably marked for ready identification.

OP 4, Volume 1, contains additional information on mixed stowage of ammunition with which the AO supervisor should become familiar.

TEMPERATURE CONTROL

Various methods are used to maintain temperature within a safe range within magazines. Insulation, chilled water cooling, ventilation, and sprinkler systems are used to reduce temperature. Each magazine may have all or some of the methods listed above, but each magazine will have at least one method of maintaining temperature within a safe range. The temperature controlling devices in a magazine determine the type of explosives that may be stowed.

Insulation

Insulation is provided on the bulkheads (except divisional bulkheads) and decks of the following:

1. All smokeless powder magazines and fuze magazines.

2. All biological, chemical, pyrotechnic, and bomb magazines when in close proximity to sources of heat over 110°F. Normally, magazines not subject to source temperatures of 110° F or more are not insulated.

Ventilation

All magazines not fitted with mechanical cooling are provided with supply and exhaust ventilation. The supply ventilation ducts in magazines and the exhaust ventilation outlets are fitted with wire-mesh screens (fig. 8-3) which must be kept clean and in good condition. Both the supply and exhaust ducts in the magazines are fitted with standard covers for maintaining watertightness. The ducts are closed with these covers during action to prevent entrance of flame from hits on the ship unless there are imperative reasons for doing otherwise.

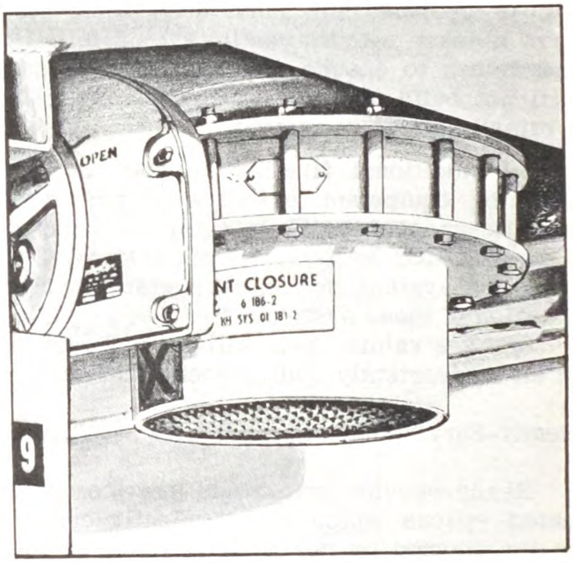

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Figure 8-3.—Ventilation closures.

Generally, there is sufficient air volume in sealed magazines and handling rooms to provide oxygen for personnel and to limit the carbon dioxide rise to a safe concentration for about 5 hours. Ether concentrations which would result from the opening of powder tanks in a magazine will produce slight intoxication without appreciably reducing the working efficiency of most persons. Consequently, temperature is the limiting factor in requiring ventilation during action, and it may be necessary to prevent temperatures from becoming excessive in uncooled handling rooms where there is considerable activity. Magazines should be ventilated or blown through after 5 hours of continuous occupancy.

Ventilation is provided to spaces aboard ship naturally or by fans and a system of ducts and closures. Fans are divided into two general classes—axial flow and centrifugal flow. Most fans in magazine duct systems are of the centrifugal type. Centrifugal fans are preferred for exhaust systems handling explosive or hot gases. The motors of these fans, being outside the airstream, cannot ignite the explosive gases, but they may overheat to a lesser degree. If the temperature of the gases is very high, the heat transmitted to the motor, through the shaft, may cause trouble.

A magazine wherein the temperature is frequently above 100 ° F, or which may occasionally reach 110 ° F, must not be used for the stowage of smokeless powder. Artificial means must be employed for reducing the temperature if it should reach 100 ° F.

Ventilating systems supplying magazines, must be operated as necessary to maintain fresh air and temperatures below 100 ° F, but aside from this requirement, they need not be operated if undesirable conditions might result; for example, any condition that might result in condensation would be most undesirable. The ventilation systems must be stopped when it becomes necessary to prevent overheating or condensation of moisture.

The following principles govern the ventilating of magazines:

1. Unless the air blown in is cooler than that in the magazine itself, the tendency will be to increase the magazine temperature, and if the humidity is high, to increase the dampness.
2. The magazine ventilation should be secured and the watertight covers should be closed whenever ventilation is not required to maintain the temperature below 100 ° F.
3. It frequently happens in hot climates that magazines can be maintained at a lower average temperature by closing off the supply of air during the heat of the day and running the blowers only at night when cool air can be forced in. This allows the magazines to heat slowly by conduction during the day, rather than rapidly increasing the temperature by forcing in air that is already heated. The specific procedure best suited for a particular magazine or condition can be determined only by trial. Once determined, however, it should be made a matter of record for future guidance.

OP 4 provides instructions for action to be taken for specific explosives when the temperature is abnormal in a magazine.

Airspace Around Stowage

Stowage of ammunition and explosives should be given considerable care so as to leave an airspace around the stow to provide adequate ventilation to all parts of the magazine and throughout the stow.

Mechanical Cooling

The chilled water type circulating system is the most common type of cooling equipment aboard a carrier. There are, in general, two types of chilled water systems—gravity and duct. With the gravity system, air is circulated by convection (fig. 8-4); that is, the air is cooled as it passes through the cooling coils. The duct system also uses chilled water and cooling coils. In this case, however, the air is circulated by a fan through the cooling coils and a system of ducts.

MAGAZINE SPRINKLERS

In the old days of wooden ships and iron men, firefighting in magazines was simply a matter of flooding the space. As the magazines were below decks, all that was necessary was a pipeline to the sea and a conveniently placed valve that could be opened in an emergency.

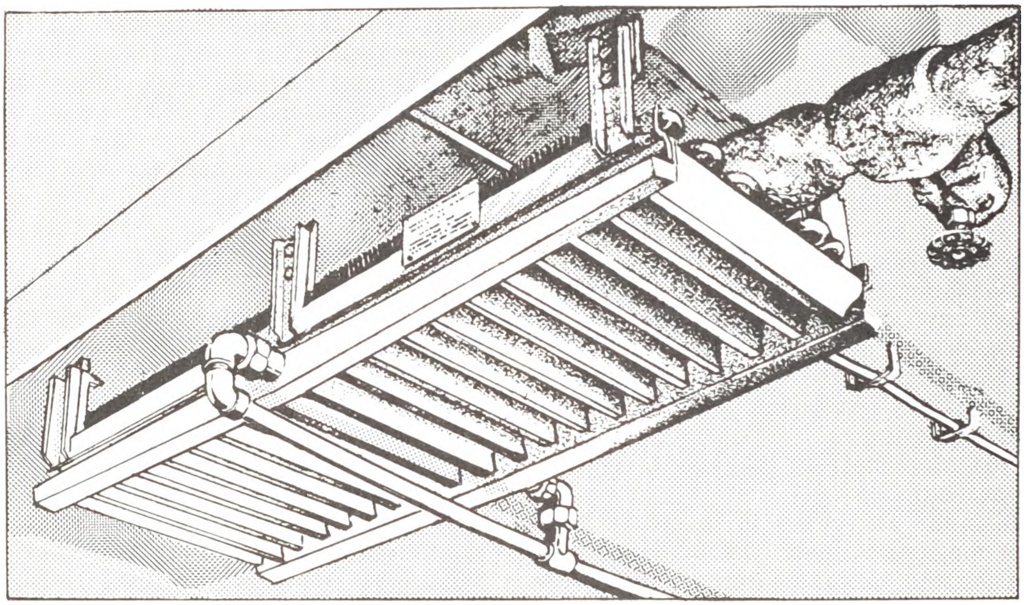
Carriers today are equipped with sprinkling systems. The systems vary considerably in complexity but can be divided into two basic types—the hydraulic system, commonly called the manual system; and the automatic system. Both systems are cross connected to a control valve in the magazine. The control valve separates the wet side of the system from the dry side. The wet side contains water under fire main pressure, whereas the dry side has no water.

The major difference between the systems is the method of actuating the control valve. With the manual sprinkling system, the control valve is operated from a remote control station equipped with a fourway control cock, hand pump, and other associated components. In the case of the automatic sprinkling system, the control valve is actuated by sensing devices which detect a rapid rise in temperature, or a slow excessive rise to a fixed temperature. Figure 8-5 is a typical remote control station.

Magazine sprinkler systems are tested periodically under the direction of the ship's gunner. Results of the tests are entered in the ship's log as well as the weapons department's log.

Sensing Devices

Most magazines are equipped with heat actuated devices, fixed temperature units, and flood alarms. These sensing devices are connected



AO.550

Figure 8-4.—Chilled water circulating system, gravity type.

to damage control central and provide a warning to the change of condition in a magazine, as well as actuation of the sprinkler system.

HEAT ACTUATED DEVICES.—Heat actuated devices are commonly referred to as HAD's. They are pneumatic thermostats installed in the overhead of the magazine. The HAD's set off the sprinkler system should there be a rapid rise in temperature. (See fig. 8-6 for a typical HAD installation.)

FIXED TEMPERATURE UNITS.—Fixed temperature units are commonly referred to as FTU's. They are spring-loaded soldered disks which are also installed in the overhead of the magazine. The FTU's set off the sprinkling system control valve should the temperature rise to 150° F. They serve as a backup system in case the temperature in the magazine rises at a rate too slow for the HAD to detect. (See fig. 8-6 for a typical FTU installation.)

FLOOD ALARMS.—The flood alarms provide a means of indicating when the level of water in the monitored magazine is above the prescribed limits for the required conditions. The flood alarm system consists of a magnetically operated liquid level switch connected to a remote monitoring station. If the water level should rise above the prescribed height, the switch will energize visual and audible alarm signals in the ship's damage control central. A typical flood alarm is shown in figure 8-7.

MAGAZINE SECURITY

During peacetime all magazines, explosive lockers, sprinkling system controls, ready-service boxes, and magazine ammunition elevator controls are kept closed and locked except when they are opened for inspection, for ventilating, for testing, or for authorized work. These locks are not opened unnecessarily; they are opened only when authorized by the officer in charge of the space, and he is responsible for securing the locks upon completion of the operation.

Magazine keys are in the care of the commanding officer or an officer specifically authorized by the commanding officer as custodian of magazine keys.

In time of war and at the discretion of the commanding officer, magazines, explosive

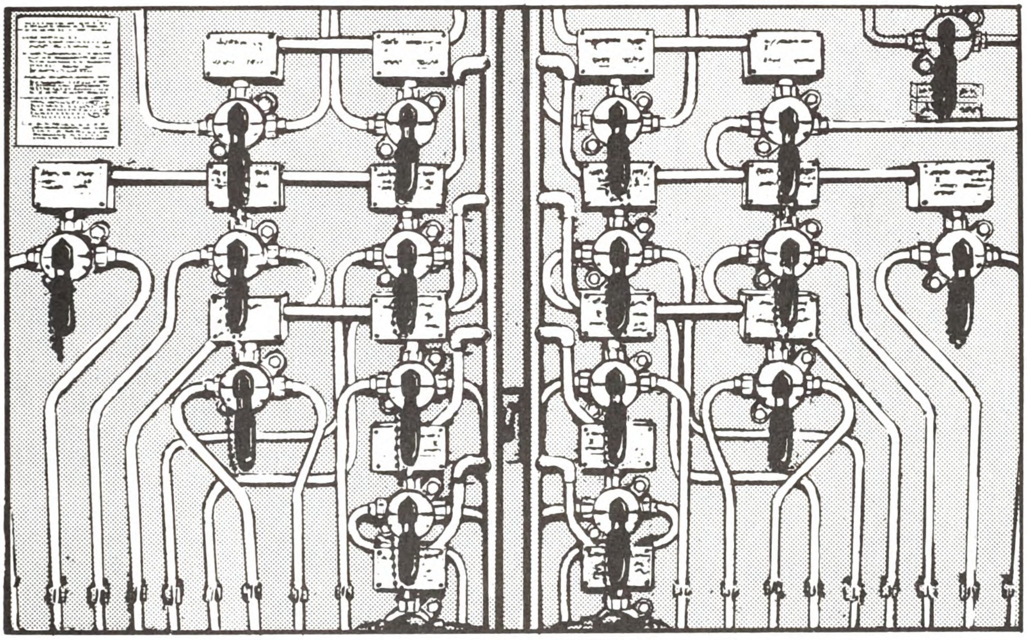


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Figure 8-5.—Remote control station, four-way control cocks.

lockers, ready-service boxes, etc., need not be secured with locks, but they should be fully dogged closed except when in use.

Many carriers maintain a two-man magazine security patrol after working hours. The purpose of the security patrol is to report any condition that is likely to cause an unsafe condition in a magazine or adjacent area, as well as checking the magazine for breaches of security.

STOWAGE

The specifications for the construction of a ship show the designated stowage of all types of ammunition and explosives on the ship's allowance. All magazines are marked by appropriate label plates designating the compartments and the types of ammunition to be stowed therein (such as powder magazines, fixed ammunition magazines, small arms magazines, missile magazines, warhead lockers, aircraft bomb magazines, projectile magazines or fuze magazines, detonator lockers, pyrotechnic magazines or lockers, and ready-service ammunition boxes, racks, or lockers). Each magazine is designed specifically for the particular type of ammunition which it is to contain. Space is

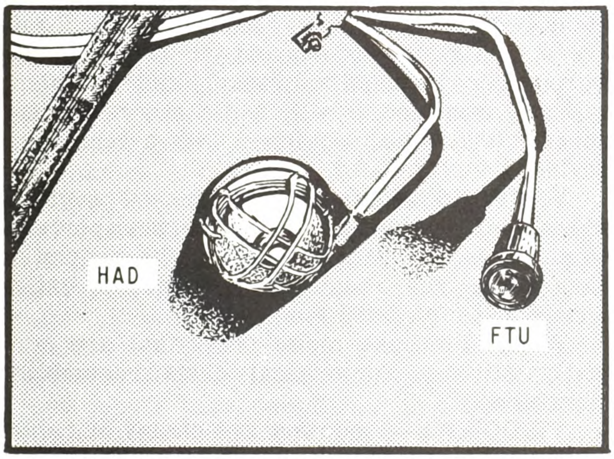

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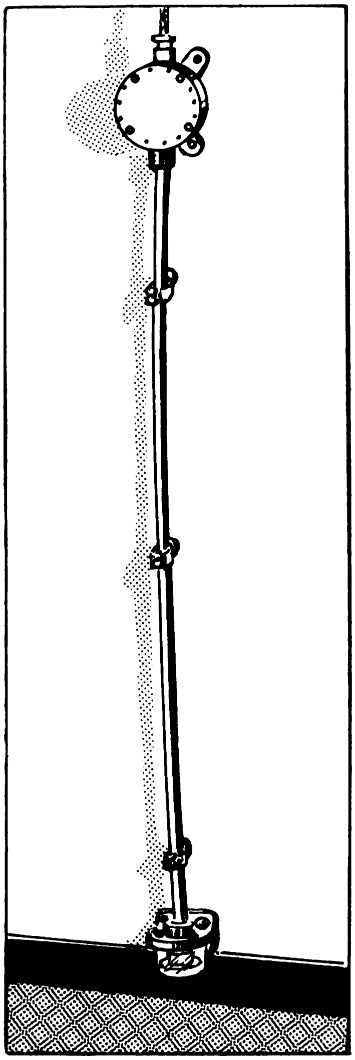
Figure 8-6.—Sensing devices (HAD and FTU).



AO.553

Figure 8-7.—Flood alarm.

provided for adequate ventilation and for handling operations. The stowage area is arranged to provide access to all ammunition and containers, insofar as is practicable. Only that ammunition which is authorized should be stowed in any magazine, except as stated in OP 4, Volume 1.

Stowage Charts

In all magazines where more than one type of ammunition may be stowed and where portable battens or alternate stowage facilities are provided to receive the various kinds and/or types of ammunition, a suitable chart showing the stowage capabilities (types, quantities, etc) and the arrangements of battens, fittings, and the like, should be provided.

Stowage Fittings

Weapons are secured in place with various types of fittings, each of which has been specifically designed for this purpose. Generally, the fittings can be grouped into the categories of deck bearers, chocks, portable stanchions, brackets, bins, and tiedowns. Although fittings within these categories vary widely in design, their basic purpose is briefly described.

DECK BEARERS.—Deck bearers are metal strips attached permanently or by removable fasteners, to the deck. In some magazines, weapons packages are placed directly on the deck bearers. In other magazines, the deck bearers are used to support chocks or as an attachment point for portable stanchions.

CHOCKS.—Chocks are metal supports upon which bare weapons are stowed. Some chocks are designed to rest on deck bearers, while others are designed to rest between portable stanchions. A typical installation of chocks and deck bearers is shown in figure 8-8.

PORTABLE STANCHIONS.—Portable stanchions are vertical posts attached to deck bearers and to the overhead. Stanchions are used to restrain weapons packages by themselves or with brackets and battens.

BRACKETS.—Brackets are metal arms attached to portable stanchions. Two brackets are normally used to support the weapon. Some weapons are secured to brackets and stanchions with a clamp and J-bolt, while others are secured with a strap equipped with a tensioning device. (See fig. 8-9.)

BATTENS.—Battens are metal sections which are installed horizontally between portable stanchions. The battens enclose the weapon on each side. The resulting enclosure is called a rack. (See fig. 8-10.)

BINS.—Bins are metal trays that are normally attached to vertical posts resembling stanchions.

TIEDOWNS.—Tiedowns are chains or cables with tensioning devices. They are attached to the weapons packages and the deck or bulkhead to restrain the packages from shifting.

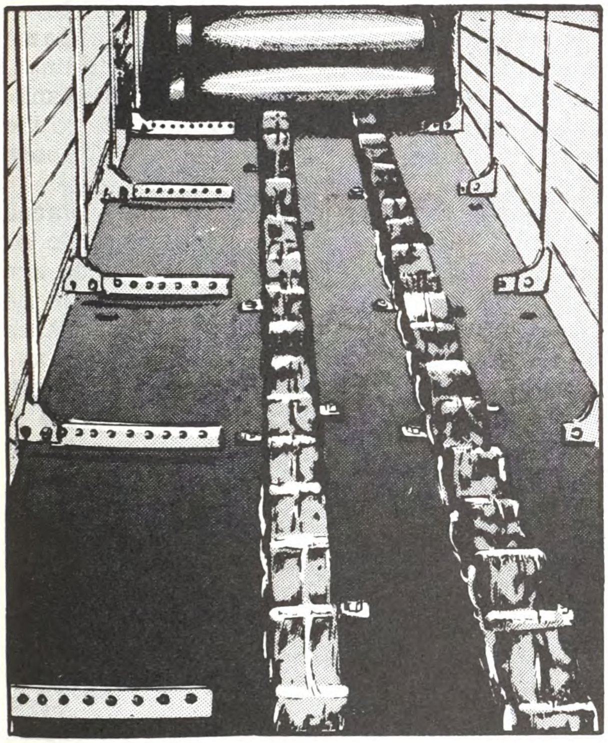


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Figure 8-8.—Chocks and deck bearers.

Stowage Arrangement

Stowage fittings are installed in numerous arrangements to stow a particular weapon or combination of weapons in a magazine.

BIN STOWAGE ARRANGEMENT.—Bin stowage arrangement is normally used to stow weapon components such as fuzes and certain pyrotechnics.

TIEDOWN STOWAGE ARRANGEMENT.—Tiedown stowage arrangements are used in some bomb magazines where pallets of bombs must be secured. A typical tiedown arrangement for a pallet of bombs is shown in fig. 8-11.

FIXED, UNIVERSAL, AND MODULAR STOWAGE ARRANGEMENTS.—These stowage arrangements have one fitting in common—the portable stanchion. The major difference between the arrangements is the method by which the portable stanchion is attached to the deck and overhead.

With the fixed stowage arrangement, the stanchions are attached to deck bearers which have been permanently installed at fixed locations on the deck. The portable stanchion is attached to the deck bearer and to a corresponding attachment point in the overhead.

The universal stowage arrangement also utilizes deck bearers with corresponding overhead attachment points. In this case, however, a row of holes have been drilled in the deck bearer and overhead attachment fittings to allow the portable stanchion to be installed at a number of locations.

The modular stowage arrangement provides even more flexibility in arranging portable stanchions. With this arrangement a grid has been installed in the deck and overhead. Deck bearers are bolted to the deck grid at a desired

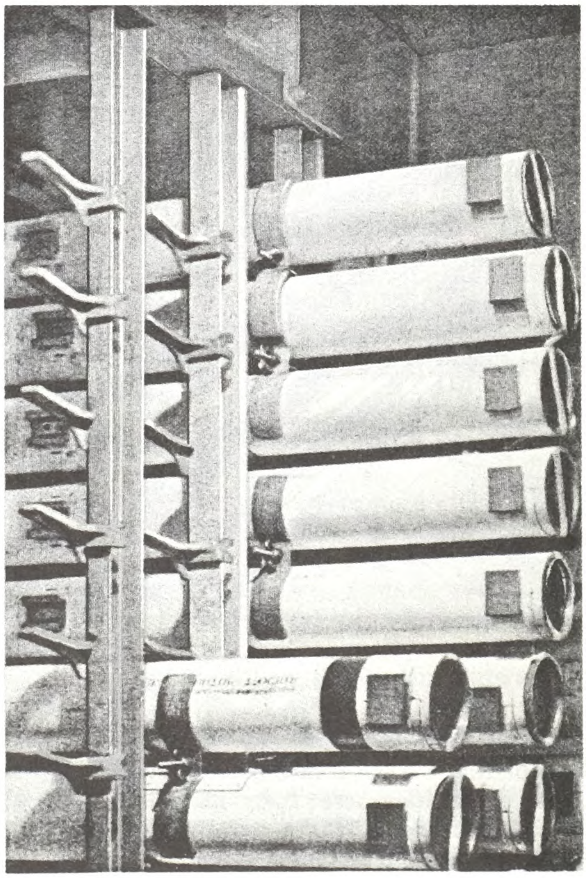

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Figure 8-9.—Brackets, J-bolts, and portable stanchions.

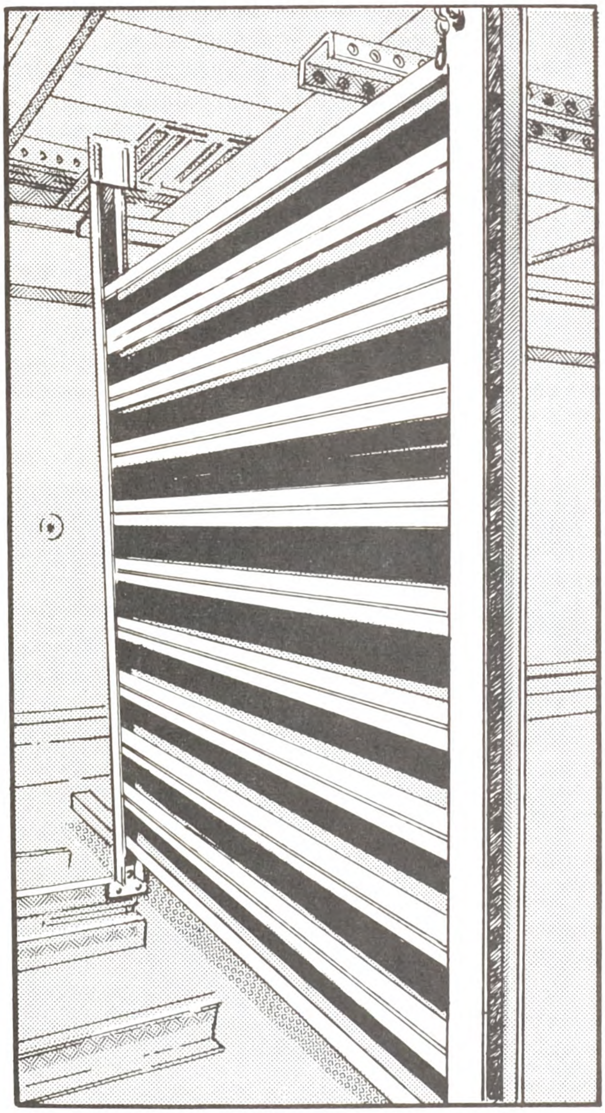

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Figure 8-10.—Battens.

location, and top supports are bolted to a corresponding location in the overhead grid. Portable stanchions are then inserted vertically between the deck bearer and top support. Figure 8-12 shows typical installations.

Instructions for securing, dunnage to be used, and other information applicable to the stowage of ammunition aboard a carrier may be found in OP 4, Volume 2. When doubt exists, a quick reference to the applicable publication will aid the AO supervisor in determining the correct and safe route to follow.

WEAPONS ELEVATORS

Weapons elevators (also called bomb elevators) used aboard a carrier operate on the same principle as elevators used in office buildings. They are designed to provide a means of transporting ammunition from the magazines to the assembly areas and then on to the weapons staging area and vice versa.

In general, bombs and rockets are placed on skids in the magazine using pneumatic or manual hoists, and then the loaded skids are placed onto the elevator to be raised to the second or third deck (weapons assembly area on most carriers). After the weapons are assembled, they are then raised to the hangar deck or flight deck staging area. The reverse is true for weapons that are not loaded or returned from a flight.

UPPER AND LOWER STAGE ELEVATORS

Two elevators are normally used to strike a weapon from the flight deck to the magazines and vice versa. The two elevators are called upper and lower stage, depending on the levels which they serve. Upper stage elevators serve magazines and compartments located between the second deck and the flight deck. The lower stage elevators serve the second deck and below. The elevators are arranged so as to prevent a weapon that might be dropped in the elevator shaft on the flight deck from falling into a magazine and causing a serious accident. Another safety feature of the two-elevator arrangement is that it keeps flammable fluids from flowing into a magazine when spilled on the flight or hangar decks. As shown in figures 8-2 (A) and 8-2 (B), a typical weapons elevator arrangement is designed to provide a means of moving ammunition from one deck to another from all ship magazines (lockers excepted).

IMPROVED REARMING RATE PROGRAM

The Improved Rearming Rate Program (IRRP) is a recent concept in ammunition handling aboard carriers. The program was designed to reduce handling time for ammunition from magazine to aircraft. As stated earlier, a bomb

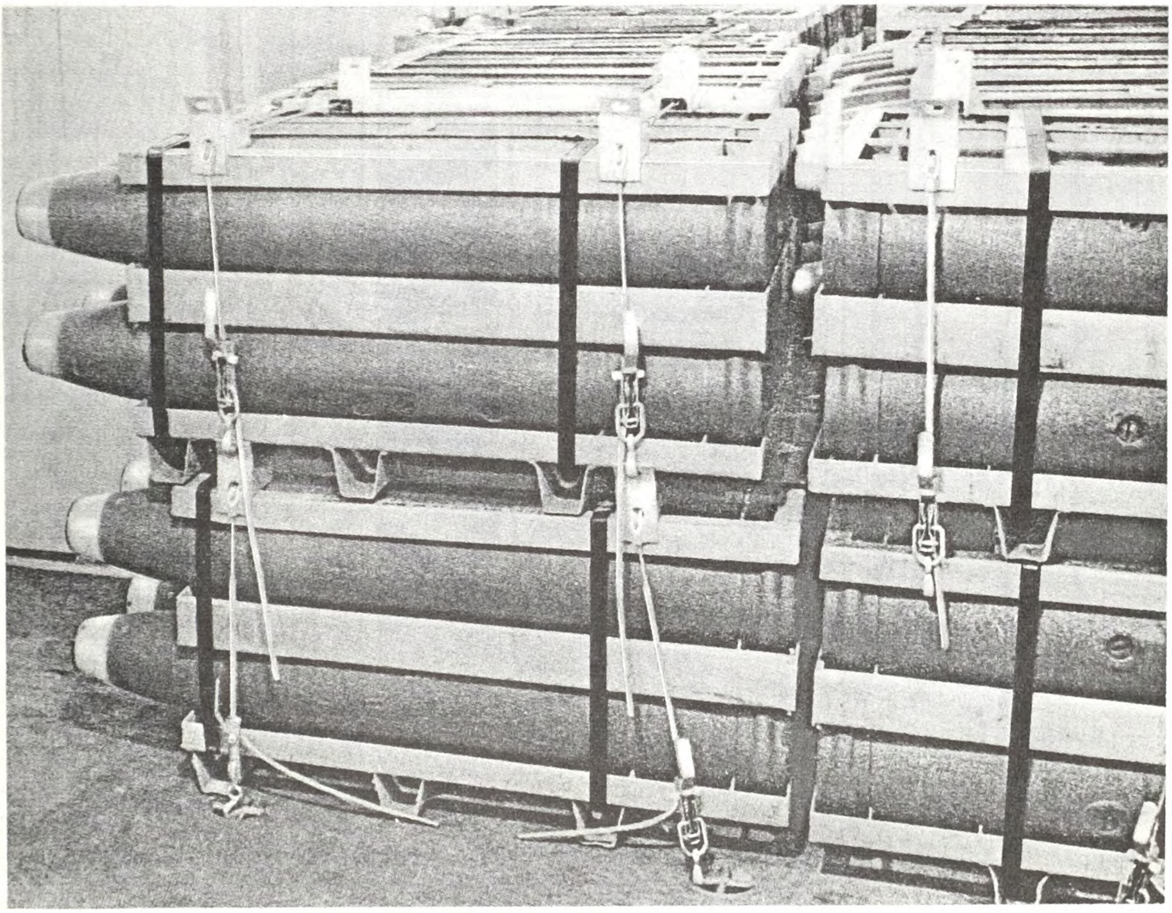

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Figure 8-11.—Tiedown stowage arrangement for bomb pallets.

is hoisted onto a skid in the magazine then transported by means of weapons elevators to the weapons assembly area by the lower stage elevators. After assembly, the weapon is moved to the staging area (hangar deck or flight deck) by the upper stage elevators. The IRRP permits the use of palletized loads, and the weapons do not have to be individually hoisted to a skid in the magazine. Electric forklifts are used to load pallets directly onto the elevator on some ships, and the pallet of bombs is not opened until they are ready for assembly in the assembly area.

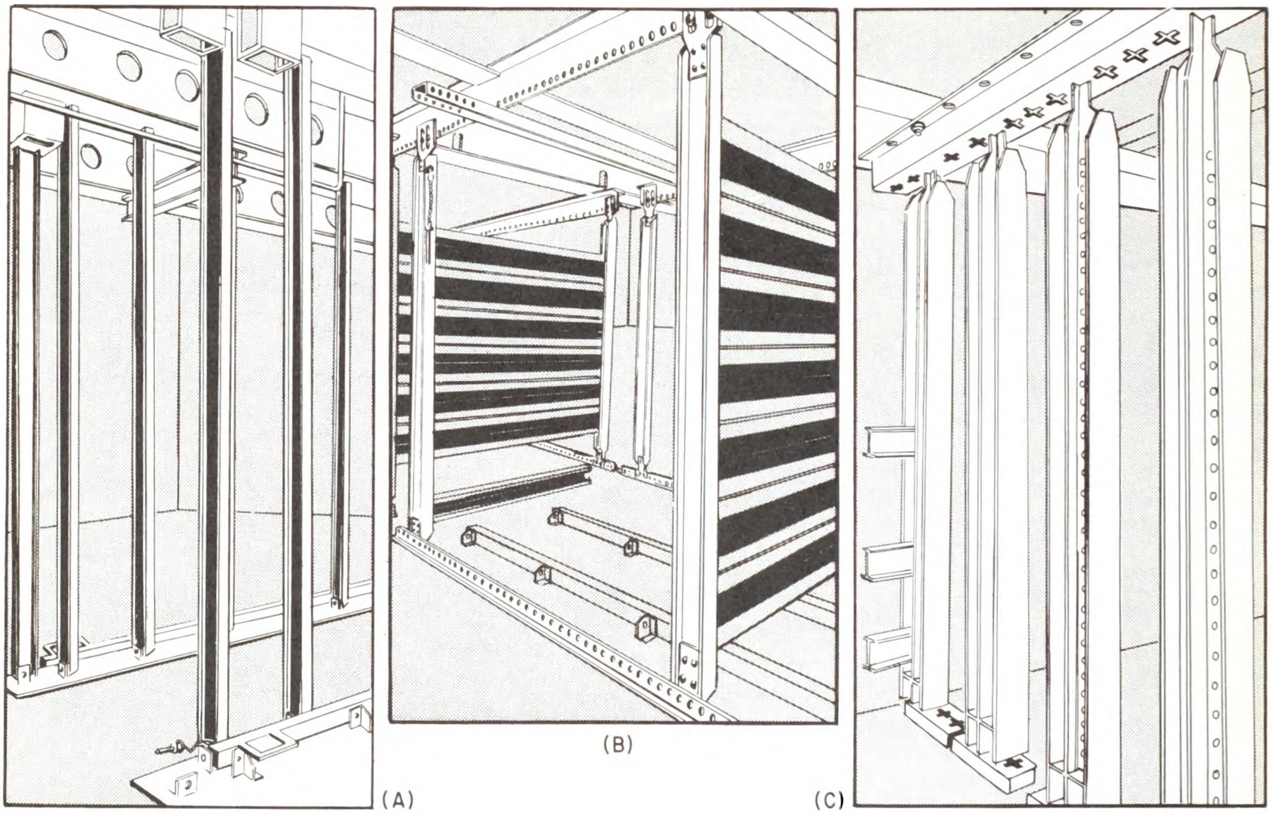
After the bombs are assembled, they can be loaded directly onto a MER or TER by the assembly crew and delivered to the weapons staging area ready to load onto the strike aircraft, thus saving the time it would have taken to load the bombs individually onto the aircraft.

Some of the modifications made to weapons elevators include the following:

1. Increase in weight capacity
2. Increase in length to accommodate a skid loaded with a preloaded MER or TER.
3. Enlarge the elevator hatch openings to allow the use of electric forklifts.
4. Installation of a weapons deck edge elevator outboard of the island on some carriers.

TYPICAL SYSTEM

The weapons elevators are operated and controlled electrically. Each elevator has its own



AO.558

Figure 8-12.—(A) Fixed stanchion arrangement; (B) universal stanchion arrangement; (C) modular stanchion arrangement.

machinery room (compartment) that contains the electric motor, cable, and pulleys that guide the cables to the elevator car.

The elevators are controlled by two men, one at each end of the desired run. They are equipped with sound powered phones, which are worn on their heads at all times when manning the elevator. (Hand phones are available as a backup.) The phones are used to allow the operators to communicate from each level at which the elevator can operate. The operators must simultaneously operate the run switches at each end of the run to complete the circuit to operate the elevator.

Stop switches are used at each deck at which the car can be stopped to insure that the car is alined with the deck so that skids can be rolled on or off the car.

The elevator shafts are a hazard when exposed. The shafts are closed by hatches when the car is not actually being loaded or serviced. The hatches are of various types, depending on the size and location of the elevator. For example, some hatches are opened and closed by an electric motor, a hydraulic system or a system of counterweights while others use a hinged hatch.

MAINTENANCE

Maintenance on weapons elevators is performed by the elevator crew of G division. Inspections and lubrication in accordance with the PMS schedule comprise the majority of the maintenance. The crew supervisor should constantly train his personnel in the operation of the elevators to insure that they possess a thorough knowledge of the system. There are no service schools available to provide trained personnel to the fleet for elevator maintenance.

On-the-job training is used to insure that personnel are capable of making minor repairs to the elevator system.

The elevators are required to be static and dynamic load tested at frequent intervals. Normally, the ship is in overhaul or restricted availability (RAV) often enough to allow the static testing to be performed at that time.

CONVEYOR SYSTEMS

The IRRP also included modifications to carriers for conveyor systems. Most carriers were modified only for the vertical conveyor system (dumb waiter type). The latest carrier design includes drive conveyors which work in conjunction with the elevators, magazine conveyors, and shuttle conveyors.

Vertical Conveyor Units

Vertical conveyors are used to hoist small items (fins, etc.) from the magazine to the second deck or hangar deck. The conveyors, with a hoisting speed of 75 feet per minute, have forklike platforms capable of handling packages as large as 24 inches by 30 inches and weighing up to 170 pounds. The Forrestal class carriers have one vertical conveyor that travels from the seventh deck to the hangar deck with openings on the second and hangar decks. The latest carriers, CVA 67 class, have six of these units that serve weapons spaces. These conveyors are commonly called "dumb waiters."

Drive Conveyors

Drive conveyors are incorporated into the weapons elevator platforms of all the upper and lower stage elevators (except one) on the CVA 67 class carriers. The drive conveyor system platform raises and lowers to permit its use. The conveyor raises when the elevator door is opened, automatically engages the shuttle conveyor or flush conveyor systems in the magazine, and automatically transfers the load to the other conveyor systems. When the drive conveyor is raised, it engages the shuttle conveyor or flush conveyor systems; the drive conveyor provides the power to operate these systems to mechanically transfer the load from the elevator platform. In figure 8-13, the drive platform is in a raised position ready to engage the shuttle conveyor.

Magazine Conveyors

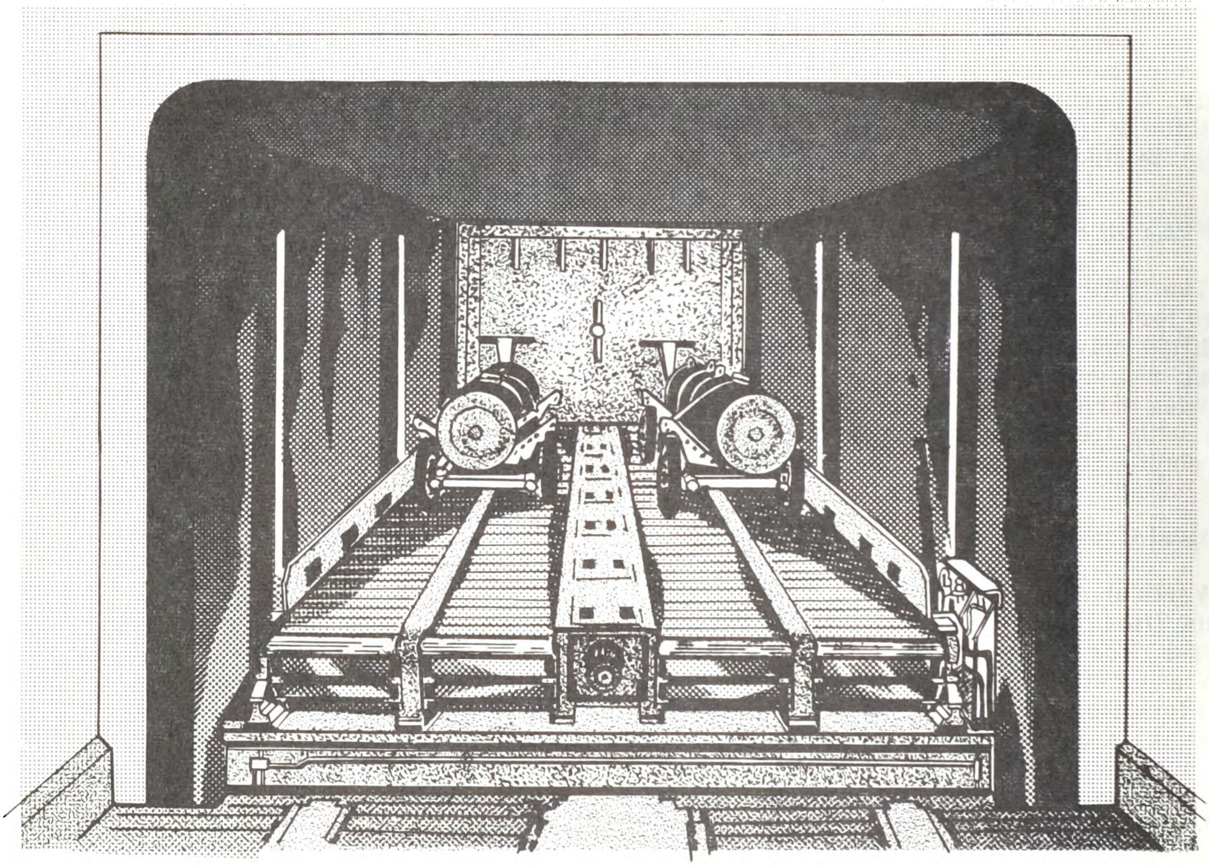
Each magazine served by a lower stage elevator, CVA 67 class, has horizontal conveyors installed in a deck recess alined with the elevator door. Magazine conveyors are installed in such a way that the drive is flush with the deck on all levels but the hold. On this deck, due to interferences with the ship structure, the conveyor is raised above the deck level. None of these conveyors have load shift prevention devices as do the elevator conveyor platforms. Magazine conveyors do not have independent drive mechanisms; power is transmitted from the elevator conveyor when the two conveyors are engaged. Engagement is accomplished when the elevator door is open and an elevator conveyor control is activated to extend the elevator conveyor to mate with the magazine conveyor. Figure 8-14 illustrates a typical installation.

Shuttle Conveyors

Three horizontal conveyor systems are provided on the CVA 67 class carriers for automated handling of weapons. These shuttle conveyor units are installed at the second deck and are positioned to transfer weapons loads between upper and lower stage elevators. Each of the three systems has two shuttle conveyors which travel athwartship and run on the same set of tracks. The tracks are recessed in the deck and are closed off with removable covers when the shuttle cars are stowed in the compartments provided at the outboard bulkhead of the transfer area. A conveyor belt is installed on each shuttle unit. Power is transmitted to the conveyor belt when the extended elevator conveyor platform is mated to the shuttle conveyor. Each shuttle is controlled by its own console located within the compartment.

A description of a typical shuttle conveyor system is as follows:

An elevator load arrives at the second deck on upper stage elevator No. 5. Shuttle No. 6 is then alined with the conveyor platform on upper stage elevator No. 5 by an automatic function initiated from the shuttle control console. Upper stage elevator No. 5 doors are opened and the elevator platform conveyor is extended to mate with the shuttle conveyor by a function at the upper stage elevator No. 5 control panel. When proper alinement is made, an indicating lamp on the elevator control panel lights and the platform



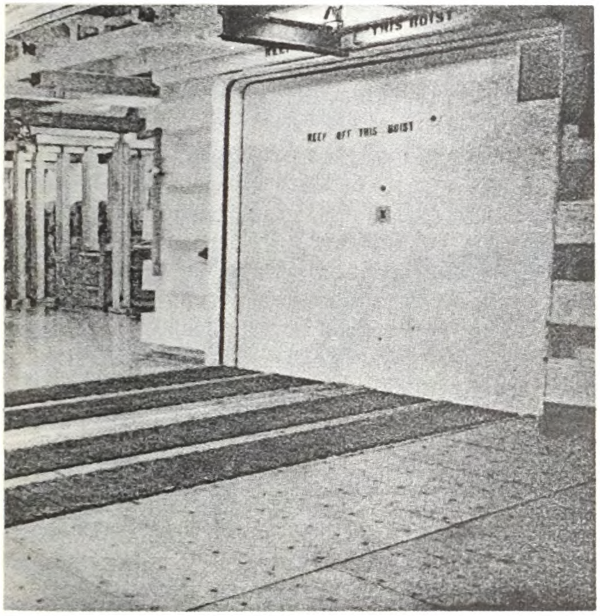
AO. 559

Figure 8-13.—Drive platform.

conveyor transfers the load to the shuttle conveyor. The upper stage elevator No. 5 platform retracts and control is assumed by the console for shuttle No. 6.

When the proper switch is actuated, the shuttle conveyor travels athwartship and alines with lower stage elevator No. 5 or 6. Control is then transferred to the control panel for lower stage elevator No. 5 or No. 6; the elevator door opens and the platform conveyor extends and mates with the shuttle. The load is then transferred from the shuttle to the elevator. The elevator platform then retracts, the door closes, and the elevator is lowered to a designated stowage space. On arrival at the magazine, the elevator control activates, extending the elevator platform conveyor to mate with the magazine conveyor. After proper alinement, the elevator platform conveyor transfers the load onto the magazine conveyor. Weapons loads are then transferred to their respective position either by an overhead handling system or by forklift trucks.

Either conveyor (No. 5 or No. 6) may assume the functions of the other, in addition to its own, at the option of the control console operator. Another mode of operation would allow each shuttle unit to travel athwartship only as far as the centerline--one shuttle servicing starboard elevators, the other servicing port elevators. Numerous interlocks are incorporated in the design of both the elevator platform and the shuttle conveyors to prevent continuity of operations if one function in the series has not been completed. For example, if the elevator conveyor does not mate properly with the shuttle conveyor, the platform conveyor will not operate. If either conveyor should become inoperative, an option is available on the elevator control panel to permit the



AO. 560
Figure 8-14.—Magazine conveyor systems.

elevator platform to stop at the deck level rather than the shuttle level. Weapons loads then would be transferred by conventional methods. The horizontal conveyor system has many other complex options and security features.

Substantially fewer people and less equipment are involved in strikedown via the conveyor system than with other methods. Operators are required for the elevator control panels and at the shuttle control console. Telephone talkers are still required at every terminal of activity—upper stage elevator loading and unloading and lower stage elevator loading and unloading. (They report the progress of weapons loads as they proceed to or from stowage and report any pertinent information to the weapons control station.) In this way, second deck clutter awaiting further transfer is eliminated, and the numerous pieces of yellow gear formerly required are no longer needed. The manpower formerly required in the magazine is still necessary to secure the weapons in stowage.

Figure 8-15 shows a typical installation of a shuttle unit and its control console.

SAFETY PRECAUTIONS

Elevator safety precautions are posted on each elevator hatch and are to be rigidly enforced. The AO supervisor should insure that he and his crew thoroughly understand them. Some of the pertinent safety precautions for weapons elevators are as follows:

1. Never ride on an elevator—some ships utilize them to transport casualties, however.
2. Hatches must be closed prior to running an elevator.
3. Two operators are to be used, one at each end of the run.
4. Insure that the hatch opening area is clear prior to opening the hatch.
5. Insure that the load is positioned and secured so that it will not shift and jam the elevator.
6. Observe all safety precautions applicable to the type of ammunition being handled.
7. All operators are qualified and certified as weapons elevator operators in accordance with OpNav Instruction 3571.3, Conventional Aviation Ordnance Qualification and Certification Program.

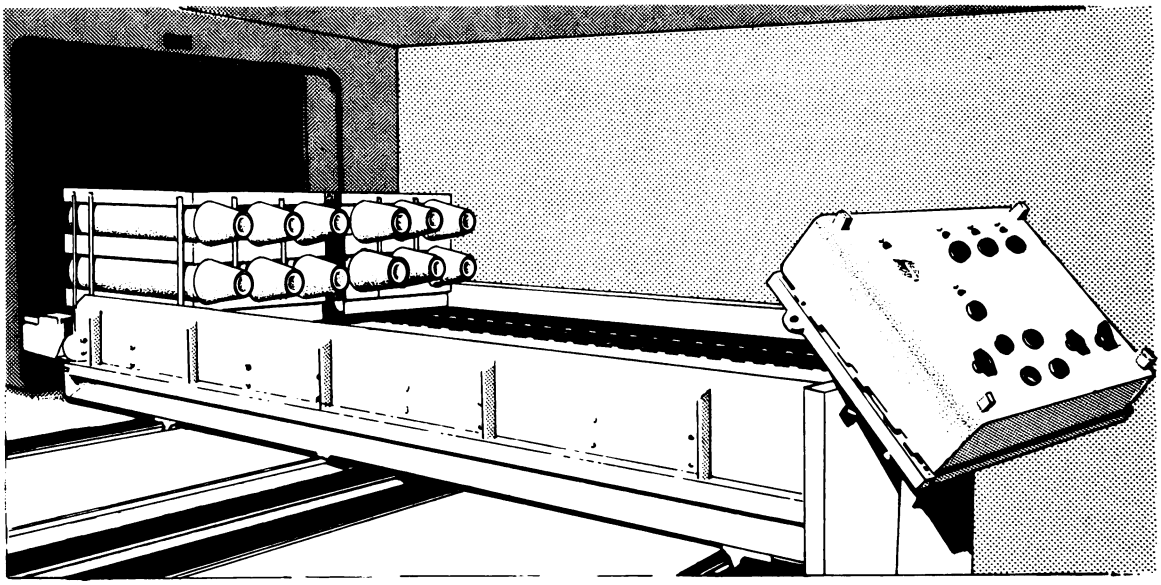
AMMUNITION HANDLING AND ASSEMBLY

Ammunition handling and assembly aboard a carrier presents hazards not found ashore; therefore, the G division supervisor must be on the alert for situations that could turn a routine job into a disaster. Assembly of bombs and rocket ammunition is normally performed on the second or third decks (messdecks) in an area designated for assembly. This area was selected for assembly due to its relative safety from electromagnetic radiation and the open space available. This is also the point of interruption in the weapons elevator system (where ammunition is transferred from the lower stage to upper stage elevators).

Personnel handling aviation ordnance must be certified in accordance with the Aviation Ordnance Qualification and Certification Program as discussed in chapter 2.

AIRCRAFT BOMBS

Bomb assembly tables (A/F 32K-1) are utilized for assembly of the Mk 82 and Mk 83 bombs, while the Mk 84 bombs are normally assembled on a skid. The bomb assembly table allows the bombs to be assembled on the assembly line



AO. 561

Figure 8-15.—Control console and shuttle unit.

process. A six-man crew is utilized to remove the bombs from the skid, place them onto the table, remove all shipping hardware, install required boosters and fuzing, install required fins, and load the assembled bomb onto the skid for transportation to the weapons staging area.

The assembly table is a collapsible metal frame that utilizes four trays that have rollers mounted on them. The bombs are hoisted onto the table by means of a pneumatic hoist (manual hoists are available for backup). After the bomb has been placed on the table, the first man removes the shipping hardware (by means of pneumatic impact wrenches), turning the bomb on the tray rollers as necessary to remove all screws and bolts. When all the shipping hardware has been removed, the tray is rolled down the table to the next man; there the adapter boosters or electric fuzing is installed as required. As the tray proceeds down the table, the fin is installed and the assembled bomb is inspected by the QA inspector. A crew that is well trained can establish a safe flow rate of one assembled bomb each 50 seconds.

For the assembly line to maintain a steady flow, additional personnel are utilized to break-out and provide fins, fuzes, boosters, and arming wires, remove accumulated trash, and provides skids.

When planning an evolution, many factors should be taken into consideration. The number and type of ammunition required, the magazines from which the ammunition is to come, the flight schedule, and the ships operating schedule for the day are some of the important ones. When possible, it is desirable to take advantage of all the weapons elevators to move the ammunition. The plan for the evolution can have bombs of one size assembled forward (forward assembly area) and another size assembled aft (after assembly area) or bombs forward and another type of ammunition aft. This will permit more ammunition to be assembled in a shorter time by utilizing more personnel.

Stowage

Aircraft bombs are stowed in accordance with OP 4, Volume 2. The class of the bomb will determine the type of stowage required. In the following sections, some of the stowage facilities aboard a typical carrier are discussed.

HIGH EXPLOSIVE BOMBS.—High explosive bombs include general purpose, low drag, fragmentation, and depth bombs. Carriers were originally equipped with only universal type magazines for stowing high explosive bombs. In this type of magazine the bombs are stowed in "cord wood" fashion between battens restrained by portable stanchions. This type of stowage was adequate during the time when bombs were supplied to the fleet unpackaged. Since bombs are now palletized into fleet issue unit loads, (FIUL), most carriers have been modified to provide several magazines for stowing pallets.

As previously noted, high explosive bombs are now supplied in palletized loads. These loads are transported by forklift trucks from the replenishment stations to a decanning area on the hangar deck. Because there are two basic types of stowage on most carriers (cord wood and palletized), there are two methods of strikedown. In the decanning area, those bombs designated for the universal and modular type magazines must be depalletized and loaded onto skids, while those going to the new palletized stowage magazines are loaded directly onto skids equipped with special pallet adapters.

Electric forklifts are used in the magazine to remove the pallet from the skid and position the pallet in the magazine, while pneumatic hoists are utilized to unload and stow the bare bombs for cord wood type magazines.

The universal and modular magazines contain numerous portable stanchions and battens which are arranged in racks to contain various quantities of bare bombs stowed in the cord wood fashion. Chocks are used to restrain the bottom row of bombs.

In the modified magazines, stacked pallets are restrained by tiedown equipped with adjustable, quick-attach devices which lock into deck-mounted fittings. Pallets may be stacked two high.

A limited number of bombs are assembled and stowed on skids in a ready-service status in both the universal and modular magazines and palletized magazines. These ready-service bombs enable the ship to react immediately to the needs of a tactical strike.

CLUSTER BOMBS.—Cluster bombs are removed from their shipping cans on the hangar deck, placed on skids, and transported to the magazine individually. The magazine contains a hoist and weapons carrier to remove each weapon from the skid and place it into the special chocks that are attached to portable stanchions. The new modular magazines provide for container stowage of the new container. The new containers will provide stowage for two Rockeyes, Sidewinder, or Shrike missiles.

FIRE BOMBS.—Fire bomb cases and napalm mix are stowed in inert compartments. Fuzes are stowed the same as bomb fuzes while the igniters are stowed in fuze lockers separate from other explosive devices due to the chemical nature of the filler used.

PRACTICE BOMBS.—Practice bombs are stowed as inert material wherever space is available out of the weather.

BOMB FUZES AND ADAPTER BOOSTERS.—Bomb fuzes and adapter boosters are stowed in magazines equipped with stowage bins or fuze lockers.

BOMB FIN ASSEMBLIES.—Bomb fin assemblies arrive aboard as palletized unit loads. They are depalletized and stowed individually in their shipping crates. Fins are stowed as inert material stacked one upon another on the deck and secured in place with portable stanchions.

ARMING WIRES.—Bomb arming wires are stowed as inert material in their shipping tubes in convenient locations to the assembly areas and to the flight deck.

Safety

Mechanical fuzing of bombs must not be done until after the bomb has been loaded onto the aircraft. When electrical fuzing is utilized, the fuze must be installed into the bomb below decks (due to electromagnetic radiation) at the time the bomb is assembled.

Assembly areas are equipped with automatic sprinklers, and the assembly area supervisor should insure that all personnel working in that area are thoroughly familiar with the system and know the procedures of manually actuating the system if necessary.

Assembly areas must be marked off to reduce the number of personnel in the area when assembly of ammunition is in progress. The smoking lamp is also extinguished in all areas where ammunition is being handled.

Assembled ammunition should not be allowed to accumulate in the assembly area. This will reduce the amount of work space available as well as increasing the danger if an accident should occur.

Detailed information on assembly and handling of bomb type ammunition can be found in OP 4, Volumes 1 and 2, and NavAir 11-5 A-17.

AIRCRAFT ROCKETS

Personnel working with aircraft rockets or any type of ammunition should be kept to the minimum required to accomplish the job, but no less than two. Rocket motors and associated components should be handled as little as possible to prevent an accident. If, during the handling, a rocket motor is dropped and any portion impacts after falling 2 feet or more, do not use the motor. If convenient, return the dropped motor to the issuing activity with a tag showing pertinent information; i.e., height dropped, date dropped, impact point of the motor, and any other information that may be useful to the inspectors. This information is used to improve the rocket design for future productions.

Electromagnetic radiation (RADHAZ) does not normally present a problem during rocket assembly when the assembly is performed on the second or third deck (assembly areas) of a carrier. Occasionally rocket assembly is performed on the hangar deck. This will require strict compliance with the ships instructions as to the RADHAZ conditions that must be set as well as increasing the precautions against a possible fire or other accident. The commanding officer's permission is required prior to assembling any type of ammunition on the hangar deck due to the potential dangers that exist. This area should be the last choice in assembly of any type of ordnance.

Rocket motors are equipped with a device to electrically short the initiating circuit of the rocket. These devices are installed on individual motors at the factory and should not be removed until the last possible moment as the motor is being loaded into a launcher. The shorting device should also be reinstalled immediately on the motor as it is unloaded from the launcher. Additional information on the shorting devices and aircraft rockets can be found in AO 3 & 2, NavPers 10345-C, OP 4, Volumes 1 and 2, NavAir 11-85-5, NavAir 16-1-529, and the NavAir Manual on the specific launcher being utilized.

Stowage

Aircraft rockets are stowed aboard a carrier in many ways, but all of them must comply with OP 4. Most rockets are packaged in launchers and are already partially assembled, while individual component (i.e., motors, warheads, and fuzes) are available to reload reuseable launchers to meet specific tactical requirements. The following sections discuss some of the most common stowage procedures for aircraft rockets.

ROCKET WARHEADS.—Zuni 5.0-inch warheads are stowed bare and individually in racks in a magazine. The bottom layer is placed on chocks which rest on deck bearers. They are secured in place with portable stanchions and battens. The Zuni warhead is not shipped in the launcher with the motor due to the size of the warhead. Some 2.75-inch warheads are shipped already assembled to the motor in the launcher, while individual heads are shipped and stowed in their shipping containers. Both the 5.0-inch and 2.75-inch warheads are stowed in accordance with the type filler used in the heads.

ROCKET MOTORS.—Aircraft rocket motors (2.75-inch and 5.0-inch) are shipped in some launchers, and individual motors for reloading are shipped in palletized unit loads. The 2.75-inch motors are shipped separate in metal containers and may be stowed in these same containers. The 5.0-inch motors are shipped and stowed in wooden boxes; however, in some magazines facilities are available to stow the motors individually on portable stanchions that utilize bolted clamps to secure the motor in place. When the 5.0-inch motors are stowed in their wooden shipping boxes, they are placed on deck bearers, one on top of the other, and secured with portable stanchions and battens. Motors are stowed in a primary powder type magazine; they may be stowed with semifixed cartridges when space limitations require. Launchers loaded with assembled rockets should be stowed separately in fixed ammunition magazines.

ROCKET FUZES.—Aircraft rocket fuzes may be stowed with the same type of bomb fuze. They may be stowed in ready-service fuze lockers or in magazines designed for fuzes.

ROCKET FAIRINGS.—Fairings used on the various launchers are stowed as inert material. The stowage spaces are normally located on the 03 level for easy access to the flight deck as well as below decks.

ROCKET LAUNCHERS.—Aircraft rocket launchers that are loaded with motors or motors and warheads are stowed separate in fixed ammunition magazines. Launchers that are empty can be stowed as inert material. The loaded launchers are stacked one on top of the other on deck bearers and secured in place with portable stanchions and battens.

Safety

Safety around aircraft rockets is a must at all times. The AO supervisor should insure that all personnel are aware of the latest changes regarding the handling and assembly of rockets.

The torque specified for assembling the warhead to the motor has to be precise; otherwise it is possible for the warhead to vibrate off during launch or recovery and cause an accident on the flight deck.

Personnel working with rockets should wear long sleeve shirts with the collars and sleeves fastened or flight deck jerseys. Insofar as possible, all work being performed on the rocket should be from the side in order to minimize the danger in case of accidental ignition.

Personnel assembling rockets should be aware of the hazards of inducing static voltage into the rocket by touching the contact band (on the 5.0-inch rocket) or the contact disk (on the 2.75-inch rocket). It is possible to ignite the rocket during the loading or unloading of a launcher if care is not exercised. The first step in unloading a rocket from a launcher is to install the shorting device as soon as the motor clears the launcher far enough. (The 2.75-inch requires the motor to be completely clear of the launcher, due to the shorting device fitting over the folding fins.)

Rocket motors should not be located in the same compartment or within 5 feet of radio apparatus or antenna leads due to the danger of igniting the rocket by induced voltages caused by electromagnetic radiation.

20-MM AIRCRAFT AMMUNITION

Most carriers have eliminated the compartments once utilized for the belting of 20-mm aircraft ammunition. Today, belting is accomplished in any compartment where space is available and free from electromagnetic radiation. Normally, the belting is performed in the second or third deck assembly areas. All current 20-mm aircraft ammunition used aboard a carrier is electrically initiated. Personnel belting or handling this type of ammunition should use care so as not to transfer static electricity from the body to the primer. It is possible to activate the primer by touching it or briskly rubbing it. Personnel that are assigned to a belting crew should be aware of these hazards, and it is the AO supervisor that is responsible for insuring that they are.

Service ammunition (20-mm) is classified and stowed as fixed ammunition. Fixed ammunition is segregated by size, type, and type of projectile, insofar as possible, for stowage. Magazines for fixed ammunition are to be equipped with racks, stanchions, and other devices to provide a rigid and safe stowage. Primary or ready-service magazines used for fixed ammunition stowage are to be equipped with temperature and sprinkler controlling devices.

Detailed information on 20-mm belting can be found in AO 3 & 2, NavPers 10345-C, and the specific OP on the belting machine being used.

READY SERVICE

Ready-service weapons are those which are assembled and made flight-ready to the extent permitted by naval ordnance regulations. Normally, when space permits, the preparation of weapons for ready service is accomplished in the modular magazine itself. The weapons are removed from containers, assembled when required, and secured to an appropriate weapons skid in the handling areas or isles of the magazine. Once positioned, the skids are secured to the deck with fittings compatible with the modular deck grid. Normally, a specified percentage of the magazine weapons load is in a ready-service configuration.

When a weapons strikeup is initiated, the ready-service loads are transferred to specified areas on the upper decks where further assembly or arming occurs. Additional loads are immediately assembled in the magazine either to satisfy additional requirements or to maintain the required number of configurations in ready service. Additional assembly areas are provided for rockets on the second deck forward where, once the weapons are assembled and on skids, they can be transferred to the flight deck for loading.

Each carrier has sufficient weapons in ready-service stowage to satisfy the tonnage requirements for any specific strike with the additional capability of maintaining this weapon flow for succeeding strikes.

Ready-service magazines are utilized on the 03 level for 20-mm ammunition. Loaded and assembled 2.75-inch rocket launchers are stowed in magazines below deck on most carriers; however, some have a magazine on the hangar deck level for ready service. Ready-service bombs are stowed in the primary magazines on skids with fins installed. (No mechanical fuzing is permitted until the bomb is loaded onto the aircraft.)

Ready-service lockers are used for stowage of aircraft parachute flares. Parachute flares and certain CBU's and missiles (such as Rockeye

2/3 and AGM A/B/C) are the only item that may be stowed in an all UP condition. Parachute flares are made ready in the taping and banding room and then stowed in the lockers. Parachute flares that are returned from the flight deck are also stowed in these lockers. Ready-service lockers are also utilized for stowage of fuzes, fire bomb igniters, marine markers, tracking flares, exercise heads for missiles, and missile motor igniters. OP 4 provides specific information as to the items that may be stowed together.

ELECTROMAGNETIC RADIATION HAZARDS (RADHAZ)

Electromagnetic hazards, commonly known as RADHAZ, are of vital importance to the AO. Electrically initiated rockets, missiles, cartridge actuated devices, and ammunition require protection from the voltages that may be induced from radar and/or radio antennas. Operating electronic equipment emits radiofrequencies (RF) that can cause enough voltage to be induced into electrically initiated ammunition to ignite it.

Each command has instructions on RADHAZ with which the AO supervisor should be familiar. NavAir 16-1-529 contains detailed information as to conditions and precautions that each type of electronic equipment and ammunition is to meet.

RECEIPT AND ISSUE

Ammunition records are kept on each transaction involving the receipt or issue of all ammunition aboard. These records are usually maintained by the ASRS crew. They work directly with the ordnance officer in all areas dealing with requesting, recording transactions, preparing reports, and maintaining records of all ammunition on board and the magazine in which each type is located. All records for the weapons department (except special weapons) are maintained by this crew.

Each carrier has a system that is utilized to maintain accurate records as to the daily expenditures, and no attempt will be made in this manual to describe the many methods used. Chapter 10 of this manual provides information as to specific ammunition reports that are required by a carrier.

HANDLING EQUIPMENT

Because the weight and shape of most air weapons are such that manual handling is inefficient and often impossible, a variety of powered and manually operated mobile equipment is available aboard ship to facilitate weapon transfer. These various types of weapons handling equipment are painted yellow and are popularly referred to as yellow gear. Included are electric and diesel forklift trucks, hand operated pallet trucks with hydraulic lift, manually pushed or pulled weapons skid, and adapters specifically designed to accomodate the variety of air weapons and components to the weapons vehicles.

Forklift Trucks

Numerous types of forklift trucks are provided for weapons handling. The diesel engine forklifts, which require adequate ventilation for exhaust, are limited to use on the flight or hangar deck. Among these are 15,000-pound capacity units and 6,000-pound capacity units. Any conventional air weapons shipping configuration now in fleet issue can be handled by one of these forklifts. All diesel forklifts employ jet aircraft fuel.

Battery powered forklifts are also available for weapons handling. Primarily intended for use in the magazines, these trucks may also be used on the upper decks for handling loads not in excess of 4,000 pounds. Most carriers are equipped with six battery powered forklifts—two working units and one standby for the aft bomb stowage and assembly magazine, and the same for the forward stowage and assembly magazines.

BATTERY CHARGING FACILITIES.—When batteries require recharging, the forklift truck is transferred, via a weapons elevator, to one of the two battery charging stations located on the hangar deck. Spare batteries are also available so that a defective battery can be replaced with a fully charged one with the aid of a hoist and battery dolly. This procedure permits a truck to be utilized while its battery is being recharged. Normally, however, a battery is charged in the truck at a charging station in lieu of exchanging the battery.

Decanning Booms

Decanning booms are located on the hangar deck to provide a ready available means for hoisting weapons from shipping containers to skids or any other requirement for hoisting weapons up to 2,000 pounds. The booms are mounted to the bulkhead of the ship in such a manner as to permit a 180° arc. A 2,000 pound capacity pneumatic hoist is provided to lift the stores. The number of decanning booms on a carrier will vary from one to four, depending on the class of carrier.

Portable Bomb Hoist HLU-196/E

The HLU-196/E portable bomb hoist is a 2,000 pound capacity gasoline engine powered hoist developed under the Improved Rearming Rates Program. The hoist is a component of the Single Hoist Ordnance Loading System which includes hoist adapters. This system employs a mechanical advantage that permits lifting ordnance loads up to 4,000 pounds.

The power unit, brake, and clutch controls are mounted on a two-wheeled steel frame assembly. A boom, which also serves as a conduit for the lift cable, is secured to the unit at the lower end with a clamp and at the other end to the aircraft rack adapter by a sheave pin.

Bomb Skids

Bomb skids, trucks, and adapters are discussed in AO 3 & 2, NavPers 10345-C. Additional information may also be found in NavAir 00-120 (Series) and NavOrd OP 2173 (3 volumes).

The AO supervisor should be familiar with the various types and configurations of handling equipment available to aid him in making decisions and plans for handling weapons in a safe and expeditious manner.

UNDERWAY REPLENISHMENT

The procedure for supplying munitions to a CVA is inherently dangerous. Initially, transfer of weapons to the carrier (onloading) occurs from a barge at explosive anchorage—a deep water anchorage selected for its isolation where, if an incident did occur, damage would be confined to that area. Hoist or cranes are used to transfer the weapons in this type operation. Subsequent replenishments can be at an explosive anchorage or the weapons can be transferred at sea while the ship is underway.

PLANNING

Since an attack carrier is at sea for many months replenishment is required many times while the ship is underway. This is accomplished by transferring weapons via a high-line rig from an ammunition supply ship (AE or AOE) to the CVA and is called underway replenishment (UNREP). Weapons are also transferred from the AE or AOE to the CVA by helicopter. Helicopter transfer is designated as vertical replenishment (VERTREP).

Many of the facilities and areas designated for movement and servicing of aircraft are utilized for weapons movement during an UNREP. Deck edge elevators, the normal function of which is to transfer aircraft between the hangar and flight decks, are used as replenishment stations. If the weapons are transferred by high-line rigs, strung from the AE or AOE to the carrier, then the elevators are positioned at the hangar deck level. If transfer from the supply ship is by helicopter, then flight deck operations are curtailed because of the transfer activity on that deck. Regardless of the method used for replenishment, aircraft must be relocated. Since weapons can be onloaded much faster than they can be secured in stowage, staging areas must be provided. As replenishment continues, the hangar deck becomes cluttered with weapons that are awaiting further transfer to assigned compartments or magazines. Doors and hatches throughout the transfer routes, normally closed, must remain open. If the carrier becomes involved with hostile forces at this time, its standby defensive capabilities should be brought into action. It is imperative that replenishment and transfer to stowage (strikedown) be completed quickly so that the ship's primary capabilities can be restored.

In an effort to speed up this operation, much effort has been exerted over the past several years in an Improved Rearming Rates Program (IRRP) for attack aircraft carriers. One concern of the project was to provide the techniques and hardware which could eliminate, or significantly reduce, the backup of weapons on the flight or hangar decks. Fleet issue unit loads was one evolution of the project. Another was assembled air launched weapons. Still another development was an automatic tensioning device on the supply ship for the high-line rig that links the carrier and the supply ship.

The AO supervisor in G or GM divisions should know the standard operating procedures of the ship in regard to replenishments. His concern with each replenishment will consist of the following:

1. Personnel assignment at each work station.
2. Accurate records kept on each item received or transferred.

3. Safety briefs held prior to each evolution, when possible.
4. Handling equipment in the required number and configuration available.
5. Weapon staging areas cleared of aircraft and handling equipment.
6. Coordinate with the messdeck chief master-at-arms to insure that routes through the messdecks are opened.
7. Keeping informed of the latest changes that occur as to the operation and briefing the crew supervisors.

The AO supervisor works closely with the ordnance officer, ordnance handling officer, and air gunner in planning the replenishments.

AUGMENTATION

Personnel augmentation is necessary to provide a continuous flow of weapons around the clock to meet tactical situations. Normally, augmentation personnel are assigned to G division from personnel in administrative or other support billets. It is the responsibility of the G division to properly train and certify these personnel in the jobs assigned them. Most carriers have a ship's instruction as to the number of personnel, division from which they are to be provided, and the job that they are assigned for augmentation.

STOWAGE

As mentioned earlier, weapons arrive on the flight or hangar decks faster than they can be struck below for stowage. Each magazine that is to receive weapons during an underway replenishment (UNREP) should be supervised by a qualified and certified AO that knows the type and quantity of weapons that the magazine is to receive. The magazine supervisor can then brief the crew as to the stowage arrangement that will be used and the proper method of securing the weapons. During an UNREP, it is imperative that all weapons are stowed as quickly as possible; but safety is not to be forsaken for speed at any time. The AO supervisor should also keep weapons control station informed as to the status of the number of weapons already stowed.

SAFETY PRECAUTIONS

There are numerous safety precautions that are applicable to the handling of aviation ordnance materials and explosives. During an UNREP, all safety precautions that are applicable to each type of ordnance being handled are to be adhered to. A safety brief prior to the evolution can aid in eliminating some of the hazardous ways that some of the personnel may use in moving ordnance. A few of the DO's for handling ammunition during an UNREP are as follows:

1. Be alert.
2. Insure that all loads are secured on skids prior to moving the skid.
3. Park skids fore and aft.
4. Keep things moving in a safe and orderly manner.
5. Use only qualified forklift drivers.

SAFETY

Particular safety precautions have been mentioned throughout this chapter. However, not enough can be said concerning safety. Safety is a responsibility of each individual directly or indirectly involved with aviation ordnance materials or explosives.

EXPLOSIVE ORDNANCE DISPOSAL

Whenever a weapon has been damaged, or determined to be otherwise hazardous through improper handling or use, Explosive Ordnance Disposal (EOD) personnel perform "render safe" procedures and determine methods of disposition. These functions are normally beyond the responsibilities of the G division or squadron personnel. EOD personnel are present on the flight deck whenever armed aircraft are launched or recovered. Although weapons are normally armed on the flight deck, other hazards can occur in stowage and/or during handling. Rendering safe and/or disposing of defective weapons below decks is included in the responsibilities of EOD personnel. It is within their purview to determine the safety and flight worthiness of weapons that have been damaged during transfer, stowage, and assembly operations.

Although all personnel associated with aviation ordnance are concerned with safe handling and stowage procedures, each division is responsible for some specific function. EOD's primary functions concerns the detection of unsafe weapons, rendering those weapons safe, and arranging for their disposal.

WEAPONS CONTROL STATION

Weapons control stations are known by many different names, depending on the particular ship, such as Aviation Ordnance Control Station (AOCS) and Aviation Weapons Movement Control Station (AWMCS). Regardless of the name, all have the same functions—to provide a traffic management organization dealing with weapons. The primary responsibility is to insure that weapons are properly configured and safely delivered to the flight deck on time and in the numbers required.

Located on the hangar deck, weapons control is the center of all activity related to weapons movements. Weapons control maintain an Ammunition Stock Recording System which provides an inventory of all weapons in stowage and their stowage configurations. When ready-service loads are built up, each is assigned an inventory number before being struck below for ready-service stowage. From that record, detailed information is available in weapons control concerning weapons, skids, and adapters involved, whether the weapons are configured for MER's or TER's, and if all stations on the MER or TER are loaded. The aircraft with which the load is compatible can also be identified. When the weapons requirements for a strike have been determined, the information is channeled with a listing to weapons controls from the ship's STRIKE operations. There is a plotting board in the room with a listing of aircraft, event number, weapons scheduled, launch time, magazines manned, elevator status, and all factual information necessary to centrally control all weapons movements. The weapons requirement for a strike can be selected from the inventory files and an efficient routing developed.

Movement of each skid load of weapons is reported by inventory number to weapons control when it leaves the magazine, when it arrives on the second deck, and when it reaches the hangar or flight deck. The time of each event it also reported. Any pertinent information, such as elevator or conveyor failure, hoist malfunctions, or any condition which may delay strike-up, is also reported. Personnel in weapons control must have any and all information which would influence decisions related to weapons movement. If an elevator should malfunction, weapons control could, having information on other weapons movement, select nonconflicting alternate routes. Since one strike involves many tons of ordnance that are moved simultaneously from many spaces, efficient central control of this traffic is mandatory.

When aircraft have been recovered after a strike, unexpended weapons are removed by squadron ordnancemen and returned to the custody of the G division. Weapons control assumes control and records the weapons by number and dictates strikedown. The order to weapons assembly crew to build up ready-service configurations for subsequent strikes is also a function of weapons control.

As stated earlier, information must be passed to weapons control as the operations develop. Installed in the assembly areas, magazines, hangar bays, on the flight deck behind the island, and in weapons control is a system that permits two-way conversations, properly known as the 46 MC. Weapons control also has several other means of communications, sound powered phones, 30 MC, 51 MC, and the ship's phone system.

These means of communications are also used in time of emergency situations around an area where explosives are located. Since weapons control has a listing of the contents of each magazine and a means of communication, decisions during emergencies involving explosives are originated there.

MAGAZINES

Safety in the magazines is paramount at all times. No flame producing devices are to be carried into the magazines at any time by any one. The two-man rule applies when entering a magazine. All explosives are to be tied down to prevent movement during rough seas. All items stowed in a magazine have to be compatible in accordance with OP 4.

HANGAR AND FLIGHT DECK SAFETY

The presence of airborne weapons outside of designated magazines greatly increases the danger to the carrier should a fire or explosion occur. The greater the quantities of weapons involved, the greater the risk. To minimize this risk, only that quantity of weapons required to sustain operations are to be transferred to the hangar or flight deck.

Airborne weapons will be positioned in such areas as to be readily available to afford adequate time for safe aircraft loading. Staging areas for assembled weapons are restricted as follows:

1. Are convenient to jettison locations.
2. Have at least two clear routes of access.

3. Are covered by sprinkler systems or manned firehoses.
4. Are located as far as possible from oxygen and fueling stations.
5. Are manned and have provisions for physically securing weapons.

Firefighting equipment must be manned as follows when live ordnance is being handled on the hangar or flight decks:

1. High capacity fog foam (HCFF) and aqueous film foaming foam (AFFF) stations, as determined by the air officer and ordnance officer.
2. One manned mobile fire unit in the vicinity of the most concentrated weapons handling area.

Staging areas are used for ready-service only, not for protracted stowage nor for extending the total weapons stowage capacity of the ship. All weapons in the staging areas are also to be on skids or trucks to permit their quick removal from a danger if necessary.

Weapons Loading/Downloading

Compliance with the weapon requirements contained in the air plan demands close coordination between the aircraft handling officer, air wing ordnance officer, and the ordnance officer. The air wing and squadron ordnance officers are responsible for advising the aircraft handling officer of any special requirements or considerations which apply to the loading of selected strike aircraft. This will permit the aircraft to be respotted for the launch, if necessary, early enough so as not to interfere with the loading of the aircraft.

Loading/downloading and fueling of aircraft will be conducted as separate evolutions. However, the commanding officer may authorize simultaneous loading and fueling when operational commitments dictate that this extraordinary action is required. In this case, loading is limited to the mechanical attachment of the weapon or store to the rack of the launcher and the connection for electrically fuzed bombs. No other electrical connection to the weapons, installation of impulse cartridges, or installation of fuzes and arming wires may be permitted while fueling of aircraft is in progress.

When required, electrical power may be applied during the aircraft loading/downloading evolution but will be held to a minimum consistent with operational requirements. Electrical power to the armament or weapons release and control circuitry must not be applied while weapons are being loaded/downloaded.

The flight deck is always the preferred area to load aircraft. Loading should be accomplished after recovery of aircraft has been complete; however, when necessary to satisfy cyclic operations, operations on the bow may be permitted while the recovery is in progress. In any event, only the minimum quantity of weapons required should be moved toward the bow during recovery operations.

Certain types of weapons (as listed in CVA/CVS NATOPS Manual) may be loaded on the hangar deck when authorized by the commanding officer. Authorization for loading on the hangar deck will be limited to aircraft scheduled for the next launch or in an alert condition.

Arming

Weapons arming will be conducted in a designated area. When forward firing weapons are involved and the NavAir Weapons/Stores Loading Checklists require, the area ahead of the aircraft will be cleared and maintained clear until completion of the launch. Arming is to be conducted only while the aircraft is at a complete stop and control of that aircraft has been turned over to the arming crew supervisor. The arming crew supervisor will use only standardized signals, as listed in table 8-2 to indicate to the pilot or ordnance personnel performing the arming.

Table 8-2. —Aircraft arming signals.

Signal		Meaning	Response
Day	Night		
1. Arming supervisor: Hands over the head with fingers touching.	Red banded wands over the head with tips touching.	Pilot, copilot/NFO: Check all armament switches OFF or SAFE.	Pilot, copilot/NFO: Raise both hands into view of arming supervisor after checking switch positions. (Hands remain in view during check and hookup.)

Table 8-2.—Aircraft arming signals. (Cont'd)

Signal		Meaning	Response
Day	Night		
2. Arming supervisor: Points at crewmember (used if applicable).	Same as day only with red banded wand.	Crew: Perform stray voltage checks.	Arming crew: Execute. Give arming supervisor thumbs up if no stray voltage exists. Night: Vertical sweep with flashlight indicates no stray voltage. Horizontal sweep indicates stray voltage.
3. Arming supervisor: Raise fist, thumb extended upward to meet horizontal palm of other hand.	Form a Tee with red banded wands.	Arming crew; Arm weapons (as applicable).	Arming crew: Execute. Give arming supervisor thumbs up when arming completed and clear immediate area. Thumbs down if a malfunction exists. Night: same as step 2 above.
4. Arming supervisor gives pilot:			Pilot:
a. Thumbs up.	a. Vertical sweep with red banded wand.	a. Aircraft is armed and all personnel and equipment clear of area.	a. Acknowledge with similar signal.
b. Thumbs down.	b. Horizontal sweep with red banded wand.	b. Aircraft is down for weapons.	b. Acknowledge with similar signal.

Hung/Unexpended Weapons

Aircraft returning from a flight with hung/unexpended weapons must notify the ship prior to landing. The air officer will pass the word over the flight deck announcing system when the approaching aircraft has hung or unexpended weapons. When aircraft are landed with hung weapons, only required personnel are to remain in the vicinity of the landing area; all other personnel are to take cover.

The squadron aircraft dearming supervisor will position himself on the flight deck during recovery operations to insure that a high degree of coordination is maintained between the aircraft directors and the dearming crew. The dearming supervisor will indicate to the plane director those aircraft which require safing prior to being taxied to the recovery area. Aircraft landing with hung weapons will have the weapons safed as soon as possible and, in all cases, prior to commencement of any postflight checks or refueling of the aircraft. Aircraft returning with hung forward firing weapons should be stopped with a clear area ahead and safed prior to being taxied into the recovery spot. Safing signals used by the dearming crew supervisor should be in accordance with those listed in table 8-3.

Table 8-3. —Aircraft safing signals.

Signal		Meaning	Response
Day	Night		
1. Safing supervisor: Hands over the head with fingers touching.	Red banded wands over the head with tips touching.	Pilot, copilot/NFO: Check all armament switches OFF or SAFE.	Pilot, copilot/NFO: Execute. Raise both hands into view of safing supervisor after checking switch positions. (Hands remain in view during safing.)
2. Safing supervisor: Points at crewmember.	Same as day only with red banded wand.	Crew: Safe weapons (as applicable).	Crew: Execute.
3. Safing supervisor: Give pilot thumbs up.	Vertical red banded wand.	Pilot: Aircraft is safed and crew and equipment are clear.	Pilot: Acknowledge with similar signal.

Emergency Procedures

In case of fire or danger of fire near weapons, the weapons are to be moved to a safe area or jettisoned as the situation dictates. The EOD officer or his representative will take necessary on-the-scene action in regard to the most hazardous weapons involved and the disposal thereof.

All AO personnel working on the flight deck should be familiar with the various locations of the jettison ramps and the procedures for rigging them.

CHAPTER 9

AMMUNITION HANDLING AND STOWAGE ASHORE

Afloat or ashore, the control of aircraft ammunition from its arrival, into stowage, and through the assembly and arming areas remains much the same. However, this requires a high degree of proficiency and the coordinated effort of reliable trained personnel. Ammunition handling crews should be thoroughly familiar with all types of ammunition being handled and the equipment used in the handling or stowing operation.

Handling and stowage of ammunition are difficult tasks for all personnel concerned. Safety precautions must be rigidly observed at all times. However, before considering handling and stowage methods, we will briefly review the term ammunition.

In the Navy the term ammunition applies to:

1. All component parts and substances which when assembled form a charge, a complete round, or a cartridge for a small arm, gun, cannon, or for any other weapon; or for explosive actuated device, impulse device, torpedo warhead, mine, bomb, depth charge, fuze detonator, projectile, rocket, or guided missile.
2. All soild propellants.
3. Hypergolic (capable of spontaneous combustion on contact) liquid propellant systems.
4. All other hazardous materials applied to ordnance uses and/or requiring surveillance for reasons of explosive safety.
5. JATO boosters, sustainers, military pyrotechnics, and offensive type chemical warfare materials.

In this discussion of ammunition handling and stowage, only those items pertaining to aviation are considered.

In many cases, the mechanical equipment used to handle aircraft ammunition is identical whether afloat or ashore. However, differences in stowage accommodations, fixed installations, working areas, and space allowances sometimes require ordnance handling equipment and procedures specially designed for the job.

The handling procedures described in this chapter are not to be considered as the only permissible ones. They are suggestions for methods of performing the necessary operations without violating safety requirements and official handling instructions. It is not to be assumed that other properly authorized methods may not be equally safe and efficient.

ADMINISTRATION

Basic responsibility for all ammunition (as defined above) is vested in the Naval Ordnance Systems Command. Such responsibility includes procurement, supply, and accounting. However, control of ammunition may be assigned to other commands and to the Marine Corps in specific instances. Commanding officers of naval ammunition depots, naval magazines, and other like activities under the direction of the Naval Ordnance Systems Command are directly responsible to the Commander Naval Ordnance Systems Command. Further delegation of responsibility and authority for handling and stowage of ammunition is made down to the individual activity ashore and afloat. Within the individual activity responsibility and authority for handling and stowage of ammunition are delegated by the commanding officer down the chain of command, to eventually become a matter within the scope of the leading petty officers.

Responsibilities for handling and stowing ammunition are clearly outlined in great detail in publications such as OP 2165, Volumes 1 and 2, NavOrd Instructions, (including BuWeps Instructions that have not been canceled), Navy Regulations, OP 4 Ammunition Afloat, OP 5 Ammunition Ashore, OP 3347 United States Navy Ordnance Safety Precatuions, and others prepared by district commandants, fleet commanders, and even duly authorized ones prepared at local levels. They are all regulatory along certain basic lines which deal with supply, procurement, accounting, allowances, expenditures, recordkeeping, safety in handling and stowage, maintenance, inspection, and surveillance.

ORGANIZATION

The leading aviation ordnance petty officer may be considered a mainstay in the organization for handling and stowing ammunition of all types. It is under authority and responsibility delegated to him that the bulk of the work incident to handling and stowing ammunition is performed. The organization of all personnel engaged in and the methods for handling and stowing of ammunition are not separate and detached functions. They are more the organization of the Navy itself. In other words, they are merely a part of the overall organizational framework of the Navy. The delegation of authority and responsibility, via the chain of command to the leading petty officers assures an organization capable of handling and stowing ammunition with maximum effectiveness and safety. A factor in this is the control which prevails at all points along the chain by those in authority. Adequate personnel to accomplish the work at hand is assured by the manner in which the organization is established.

General instructions for the proper handling of ammunition and components are included in the publications listed earlier in this chapter. These publications contain the basic regulations necessary for general instructions of personnel but do not list specific regulations or precautions applicable to particular marks and modifications of equipment; neither do they contain regulations governing equipment recently procured by the Navy. Therefore, it is the responsibility of all supervisors concerned with ammunition handling to see that operating and maintenance personnel have access to, and are familiar with, all special ordnance publications dealing with specific types of ordnance material with which they work.

The handling and stowage of ammunition are arduous and tiring operations, usually requiring large numbers of personnel for many hours at a time. It therefore is extremely important that detailed plans for personnel, organization, routing, and equipment be prepared and distributed for study well in advance. All supervisory personnel should be familiar with the work to be accomplished in order that the operations may proceed with safety and a minimum of delay.

Before loading or unloading ammunition, a preliminary conference of the weapons officer and other supervisory personnel should be held with regard to shipment orders, methods and locations of deliveries, availability of equipment (fixed and mobile), tabulation of procedures to be employed, routing to stowages, communications, working parties, special crew feeding, and other matters of joint concern.

RECEIPT AND SHIPMENT OF AMMUNITION

Handling of ammunition whether in receipt, shipment, transshipment, or other transactions in which ammunition is actually moved, involves great potential dangers. Therefore, safety is the prime consideration in any such movement.

Before taking aboard ammunition received in any conveyance, an inspection is made of the condition and security and the contents checked against the involved quantities. A report of any shortage, error, defect, or discrepancy is made. Ship and shore stations receiving ammunition in leaky containers or ammunition showing evidences of rough or improper treatment, should investigate the circumstances immediately and submit a complete report to NavOrdSysCom.

A copy of the completed invoice accompanies every delivery or shipment of ammunition. When explosives and ammunition are shipped, the material is carefully identified on bills of lading or shipping ticket by shipping name, caliber, mark and model number, manufacturer's name or initials, lot number, and such other information as may be required by other instructions.

OP 2165, Navy Transportation Safety Handbook, Volumes 1 and 2, contain complete instructions for transportation and stowage of ammunition and explosives.

When shipment of ammunition is made which must cross state boundaries, the regulations of the Interstate Commerce Commission must be met with few exceptions. These regulations are spelled out in several publications issued by the Commission. The military is permitted to make shipments which do not comply strictly with the Commission's regulations. However, such shipments are held to an absolute minimum and every possible effort is made to actually be in compliance with the Commission's regulations in each such shipment. Prior to packaging and packing, all ammunition is laid out, counted, and checked. A packing slip showing the date and names of the packer and checker is placed in each case. Heavy articles are separated from light ones and not packaged or packed together. Articles of different freight classifications should not be packed together as all articles in the same case will take the classification of the articles classified the highest.

When a shipment of ammunition is received, by any mode of transportation, a working party of sufficient size should be duly organized to properly handle the contents of the shipment. If, after commencing the job of handling the ammunition, it is seen that all of the personnel in the working party are not needed to effectively carry on the work, all excessive members of the party should be promptly assigned elsewhere. This safety precaution will prevail at all times that ammunition is being handled—only those actually needed should be allowed to remain in the area.

In many instances, personnel who are not familiar with the potential dangers involved in handling ammunition are assigned to working parties. These personnel should be briefed prior to receipt of the shipment.

Air station weapons branches whose duties include servicing and off-loading ammunition from aircraft carriers must remain in constant readiness for this work. No matter what the service required by the carrier, the weapons branch must stand ready to lend effective assistance. Cooperation must be at its highest between the weapons branch and the carrier in order to mutually solve the problems pertaining to ammunition handling, stowage, and rearming.

The weapons branch normally will not maintain its own rolling stock, or handling equipment. The transportation department of the air station has this duty. Therefore, arrangements have to be made for preventive maintenance and servicing of the heavy equipment by the transportation department. The light mobile equipment is usually maintained in the ordnance garage or shop. The use of light mobile equipment must be rigidly controlled due to the fact that there is normally a tendency to use this equipment for other than aviation ordnance work.

All safety precautions pertaining to driving and care of the mobile ordnance equipment must be rigidly enforced. Further, regulations concerning the convoys prescribed, red flags, load tiedowns, brake conditions, routing to avoid congested areas, loitering of the drivers, smoking, enroute inspections, and other safety items will have to be brought to the attention of all hands regularly and frequently.

AMMUNITION CONTROL AREAS

For purposes of regulating ammunition movements ashore, the five following control areas are distinguished:

1. Ammunition arrival area.
2. Ammunition receiving area.
3. Magazine or stowage area.
4. Delivery assembly area.
5. Aircraft arming area.

The ammunition arrival area may be a station dockside or a railway siding, or a revetted area or siding used by motor trucks or railway cars.

The ammunition receiving area ashore is the transfer location within the magazine area where inspection, inventory, and unloading are accomplished prior to delivery to the magazines. This area must comply with all regulations governing dispersal of units and permissible distances between buildings and magazines.

The magazine or stowage area, afloat or ashore, is the location with fixed installations, designed for stowage of all the various types of aircraft ammunition.

The delivery assembly area is the location to which the various components and details of ammunition are delivered for assembly into complete rounds for use in aircraft. For reasons of safety, this area ashore is remote from the magazines and from the aircraft arming area.

The aircraft arming area is the location where aircraft are parked for weapons servicing prior to launching. Ashore, it is the hangar apron operations line. The location is a matter of operating doctrine; the arming, however, should always be performed at the last moment and in a location consistent with operational schedules and the safety of the ship and its personnel.

COMMUNICATIONS

Reliable communications systems are necessary for ammunition handling and all phases of aircraft arming operations. It is important that all stations involved in the movement of ammunition (central control, magazine breakout, fuzing, assembly, arming, and other key points) be connected by telephone or some alternative method. The ability to increase or decrease, modify or reverse, the flow of ammunition and other materials can be accomplished only with an effective system of conveying orders. Ashore, where instructions may have to pass through more than one activity or command, misunderstandings are likely to occur at the junction point where messages are transferred. Frequent checks of all equipment and rehearsals of communications procedures should be made.

TIME STUDIES

In the interest of efficiency, time studies should be made of all ammunition handling and aircraft arming operations especially when new equipment, procedures, weapons, or types of ammunition are involved. In planning complex aircraft arming schedules, supervisory personnel need accurate data on the following and similar factors:

1. The time required to convey original orders from control to magazines.
2. The arrival time of the first loads of ammunition requested.
3. Magazine loading times for single loads and various multiple-load combinations.
4. Loading times for singles and multiples of various aircraft types.
5. Handling times in the magazines.
6. Assembly times for components.
7. Delivery times.

A forecast, taking all these factors into consideration, should be available for estimated loading times of one, six, or a squadron of aircraft. Such a forecast should make some allowance for crew fatigue and for unforeseen interruptions.

RECORDS AND REPORTS

Commanding officers of ships and shore activities are required to make reports of all ammunition and ammunition details within their commands. These records show all receipts, transfers, expenditures, and quantities on hand. Also included in these records are complete ammunition identification data, including lot numbers and mark and modification numbers of all ammunition and ammunition components. Commands held accountable for ammunition are responsible for submitting reports regarding transactions, inventories, performance, and similar items in strict accordance with Navy Regulations and NavOrd Instructions, or other competent authority.

Daily magazine temperature reports are made by each command accountable for ammunition. These reports are compiled from the temperature readings taken at a specified time each day in a representative number of magazines, dumps, or ready lockers under the cognizance of the commanding officer of the activity. Temperature entries are made in rough and smooth magazine logs both ashore and afloat.

All ships, squadrons, and bases outside the continental U.S. are required to submit ammunition assets and expenditure reports to Commander Service Forces Atlantic (ComServLant) or Commander Services Forces Pacific (ComServPac), as appropriate, who will in turn report to Ships Parts Control Center (SPCC). Format and frequency of this report is contained in ComServLant Inst 8015.2 (Series) and ComServPac Inst 8015.5 (Series). Continental United States (CONUS) activities such as training squadrons, reserve squadrons, and reserve ships submit ammunition assets and expenditure reports to SPCC in accordance with SPCC Inst 8010.12 (Series). These reports, when processed by SPCC, provide Naval Ordnance Systems Command and Naval Air Systems Command with information concerning expenditure rates, ammunition availability, and facts from which fleet requirements can be determined.

There are numerous other reports that have to be made periodically concerning ammunition whether afloat or ashore. Some of these reports are as follows:

1. Available stowage space at the activity.
2. Types and number of missiles used for training.
3. Performance of ordnance equipment.
4. Performance of pyrotechnics and other types of ammunition used.

Each Aviation Ordnanceman First Class or Chief should know the contents and application to their command of SPCC Instruction 8010.12 (Series). ComServLant Instruction 8010.2 (Series) and ComServPac Instruction 8010.5 (Series) provide the AO supervisor with detailed procedures for preparing ammunition request and ammunition expenditure reports. Sample requests and reports are contained in these instructions for handy reference.

MAGAZINES

MAGAZINE SYMBOLS

Ammunition depots and other shore activities number their magazines in accordance with certain specifications. These numbers are assigned so that inspecting officers and others concerned may at a glance be able to tell how much ammunition can be safely stowed therein, if the magazine is standard, or if it is a nonstandard magazine. Being nonstandard, he will further know that a check is necessary to determine if the amount stowed therein can be safely carried as marked on the magazine.

There are 16 standard types of magazines. The nonstandard magazines have a separate listing with letters X, Y, and Z added to their designators. In addition, the standard magazines, which have less than the prescribed safety distance from other magazines or inhabited areas, carry the above letters in their designators. Numbers are added to the letters to indicate the location of the magazine. The numbers and letters are painted on a colored background to indicate the nature of the hazard.

The color-hazard background should be at least 24 inches high and 36 inches long, where practicable, and painted in the position that is most conspicuous from the direction of normal approach. Background colors should conform to the designations given in table 9-1, and always indicates the current magazine contents. This provision is mandatory as an aid to firefighting personnel, inspectors, and the like. When the hazard of the contents of a magazine is not that indicated by the original color background, temporary placards or metal plates painted the proper color may be superimposed over the original color-hazard background. Such temporary placards or plates should be removed when the magazine reverts to its designed or originally assigned stowage.

Table 9-1 gives the various color-hazard backgrounds for many of the explosives that may be stored in magazines.

Numbers and letters of the magazine designator should be at least 12 inches high and located in the center of the color-hazard background. The numbers and letters should be white except when against a white, yellow, or white and yellow striped background, when they shall be black.

Magazines at the time they are built are generally so constructed and located that they are most suitable for the stowage of one of the three hazard classifications: explosion, fire, or missile. Although utilization of one type magazine for stowage of materials of another hazard classification is permissible within limits specified in OP 5, the magazine designator always indicates that type of stowage for which the magazine was designed.

The letter X on the nonstandard magazine stands for explosive hazard magazine; the letter Y for fire hazard magazine; and the letter Z for missile hazard magazine. As an example, 7DT28 on a yellow background indicates that the magazine is located in group 7, is of the 52-foot dome (Corbetta) type, barricaded, located at least 3,150 feet from the boundary, and at least 400 feet from the nearest magazine; is number 28 in that group; and contains high explosives. The distance from the station boundary or the nearest inhabited building, public railway, or public highway is another of the factors governing magazine designations.

The identification numbers outlined above are in addition to any other numbers appearing on the buildings as desired by the station or as required by other authority, and shall be the most conspicuous. Any other numbers appearing on the structure should be located so as not to be confused with the color-hazard background or magazine designator.

MAGAZINE DATA

Certain data concerning magazines are retained by all activities responsible for stowage and handling of ammunition. These data include copies of corrected blueprints, maps, and drawings of all explosive and ammunition stowage, showing the location of all magazines and magazine areas. It also includes the type and construction of the magazines, permissible stowage; maximum permissible quantities; actual contents, and distances to inhabited buildings (off naval reservation); and public railways and highways. Each activity supplies to NavOrdSysCom periodically corrected charts and other source materials which keep the Command current on all stowage problems and facilities at the activity.

STOWAGE REQUIREMENTS

As a general rule, stowage facilities ashore (an air station, for example) will include provisions for high explosives, fuzes and detonators, JATO, rockets, small arms ammunition, pyrotechnics, fixed ammunition (20-mm and larger), inert materials, and smokeless powder. The location and capacity of the magazines will depend on the type of stowage involved. For some explosives, this is in terms of net pounds.

Table 9-1.—Background color designations for magazine contents.

Magazine contents	Color-hazard background
Bulk high explosives, demolition charges, rocket heads of more than 200 pounds gross weight, bomb-type ammunition, projector charges, and other ammunition subject to detonation en masse	Yellow.
Bulk black powder, saluting charges, unassembled ignition ends, and other ammunition containing black powder as the primary charge	Yellow.
All projectiles, rocket heads of less than 200 pounds gross weight, except 7.2-inch rocket heads	Green.
Fixed ammunition of 20-mm and larger sizes, explosive-loaded rocket heads and rocket motors when packed together, and fixed and semi-fixed Army types of ammunition	Red.
Bulk propellant powder, separate loading cartridges, bag charges, rocket motors when packed alone, guided missile boosters and sustainers designated as fire hazard material, and similar items containing propellant powders as the primary charge	Blue.
Small-arms ammunition	White.
Pyrotechnics	White.
Fuzes, detonators, primers, and similar initiating devices	Red and yellow diagonal striped.
Chemical ammunition, including smoke drums (chemical ammunition group letter is to be indicated in black on the color-hazard background in addition to the magazine designator)	White and yellow diagonal striped.
Inert, combustible ammunition components	Brown.
Inert, noncombustible ammunition components	Black.
Filling houses, loading plants, ammunition production and overhaul buildings, and other explosives operating and assembly buildings, regardless of contents	Orange.

In others, it is based on the use of 70 percent of the gross floor area and a stowage height of 6 feet. For inert storehouses, the same floor area regulation applies, but the height may be greater. The overhead in a standard storehouse is 14 feet. Regulations for the stowage of special weapons are not considered in this chapter.

In order to better illustrate stowage requirements, it might be well to consider a specific example. The requirements for small arms ammunition and/or pyrotechnics are cited as the example. In general, these types of ammunition, and all others classed as nonmass detonating, are each stowed in separate arch type, earth-covered magazines, without a barricade at the door end. The standard size for such a magazine is normally 25 feet by 50 feet. When stowage space for any one type of ammunition is greater than the capacity of the size magazine, additional magazines of the same capacity are required.

Minimum safety distances for small arms ammunition have been established as follows:

1. Between magazines containing these types—200 feet.
2. Away from high explosive groups—1,900 feet.
3. Away from single high explosive magazine—500 feet.
4. Away from other types of magazines—200 feet.
5. Away from station boundary, inhabited buildings on and off the station, public highways and passenger railways—400 feet.
6. Away from centerline of runways and/or taxiways—750 feet.

An exception to both (1) and (4) above occurs when the "triple-arch" magazine is used. Then the minimum spacing between two adjacent magazines of the same type and between the triple-arch and the other magazines, except high explosives and fuze and detonators, must be 300 feet.

Small arms ammunition is stowed in separate magazines of the type used for projectile smokeless powder. It is not classified as an explosive hazard, but rather as a fire hazard. High temperatures and dampness are detrimental to this ammunition. It should be stowed by lot number and type, with each pile placarded to show readily all pertinent information. Tracer ammunition should be segregated.

Inert components and nonexplosive details not assembled with ammunition should not be stowed in magazines with live ammunition or explosives. They should be stowed in packing boxes and placed on dunnage for protection from dampness.

Rocket components offer particular hazards in stowage. Rocket heads loaded with TNT, Composition B, or HBX are stowed in high explosive magazines. The rocket fuzes, however, are stowed in regular fuze magazines. The motor itself presents only a fire hazard and may be stowed with fixed ammunition. A limited number of assembled rockets and missiles may be stowed in ready-service lockers, at a point physically convenient to the aircraft arming area.

Pyrotechnics should not be stowed with other ammunition. They should be stowed in a dry, well-ventilated place out of the direct sunlight, and should be protected from excessive and variable temperatures. The distance requirements for pyrotechnics are the same as for smokeless powder.

Bomb type ammunition is usually regarded as the most hazardous type of ammunition because of its tendency to detonate "en masse" if exposed to fire or shrapnel which may enter the magazine where stowed. It must be stowed in a fireproof high explosive magazine on noncombustible dunnage. Arch type, earth-covered magazines must be used to stow this type ammunition. The detonators for this type ammunition must be stowed separately in standard detonator magazines.

Fuzes, tracers, primers, boosters, and detonators not assembled in ammunition should be stowed in standard earth-covered detonator of fuze magazines.

INSPECTIONS

General inspections are to be made in accordance with the frequency schedule listed in table 9-2. The commanding officer, or his designated representative, is responsible for insuring that regular and frequent inspections are made of each magazine to determine if repairs are needed; to make sure that the safety regulations, particular those in regard to cleanliness and elimination of fire hazards, are being observed; and to ascertain that materials are not deteriorating into an unsafe condition, and that they are stowed in an orderly, approved manner as specified in OP 5, Volume 1.

A representative number of magazines in each group, containing representative quantities of each type of material, is to be inspected each workday. Different magazines, within the

Table 9-2. —Magazine inspection frequency.

Item	Type of magazine	Outside temperature	Frequency inspection
Smokeless powder (bulk, semi-fixed, and fixed), pyrotechnics and chemicals.	Above ground.	Below 100° F	Monthly.
		Above 100° F	Daily (1).
	Earth covered.	Below 100° F	Quarterly.
		Above 100° F	Weekly (1).
Remaining ammunition.	Above ground.	Below 100° F	Quarterly.
		Above 100° F	Monthly.
	Earth covered.	Below 100° F	Quarterly.
		Above 100° F	Quarterly.

NOTE: (1) Inspect 10 percent of magazines; in event outside temperature of any one magazine is found to be above 100° F, inspect magazines 100 percent and take action as required by OP5, Volume 1.

respective groups, should be inspected on successive workdays until all magazines have been inspected. Frequency of inspections may be varied on the basis of prevailing outside temperatures as indicated in table 9-2.

Magazine inspections are made during daylight hours to insure that sufficient light is available to note any substandard conditions.

Magazine areas are also inspected to assure that firebreaks are being maintained, that fire protection equipment, when required, is available and serviceable, that roads are in a good usable condition, and that fences are secure.

Additional inspections are required and are listed throughout OP 5, Volume 1.

The date and hour of each inspection is noted and recorded in a magazine inspection log over the signature of the person who makes the inspection. Substandard or abnormal conditions are to be reported promptly to the officer or supervisor in charge of correction, and the conditions observed noted in the log. When conditions are satisfactory and normal, they are also noted in the log by the entry "normal." Magazine inspection logs are kept for 1 year.

STOWAGE COMPATIBILITY

Certain types of ammunition and ammunition components may be stowed together, but only those that are listed in OP 4, Volume 2 (chart of permissible stowages of ammunition and explosives).

Prior to stowing ammunition, the supervisor should insure that the ammunition to be stowed is compatible with the contents of the magazine to be used.

(OP 1631 provides information as to the hazard classification of explosives.)

QUANTITY AND DISTANCE REQUIREMENTS

Quantity and distance requirements for the Naval Shore Establishments are based on records of actual fires and explosions involving ammunition and explosives. The requirements are designed to render the inhabitants of nearby communities, the personnel of Naval Shore Establishments, and adjacent public and private property reasonable safety from injury or destruction from possible fires or explosions, and to keep to a minimum the loss of valuable ammunition stores (including inert stores) resulting from fire or explosion. Quantity and distance requirements are not applicable to explosives while in transit (Interstate Commerce Commission regulations apply at that time).

Naval Shore Establishments that are unable to comply with quantity and distance requirements, as defined in OP 5, Volume 1, are required to obtain specific authorization for waiver from NavOrdSysCom.

BASIS FOR QUANTITY-DISTANCE TABLES

Quantity and distance tables are based on some of the considerations described in the following paragraphs.

Amount of Material Involved

The potential hazard area surrounding accumulations of explosives increases as the quantity of explosives is increased. It is therefore desirable to minimize the quantities of explosives at any one location insofar as is consistent with operating requirements and maximum utilization of land. Limits have been established in most cases for the maximum amount of explosives in any one pile and in any one magazine, and the distances that such piles or magazines are to be separated. Whenever practicable, the specified distances should be exceeded to afford greater safety.

Type of Material Involved

The dangers or hazards involved in the stowage of ammunition and explosives are not measured solely by the quantity of explosives stored, but also by the kind of explosives and the type of ammunition. Ammunition and explosives used by the Navy are classified into certain broad subdivisions or groups for purposes of storage. The materials within each group present the same general type of hazard and are therefore stored in the same general manner. OP 1631 indicates types of ammunition and explosives which may be stored together in the same magazine when the preferred separate storage is not available.

Segregation of Material

Some explosives are more hazardous than others, and some are potentially more hazardous when stored with others. Therefore, the segregation of different types of ammunition and explosives, as defined in OP 1631, is imperative. Magazines of different sizes and designs are utilized, depending on the character of the material involved.

Fire Hazard Materials

The damage capabilities of ammunition and explosives which present a fire hazard only are generally no greater than those of similar quantities of other highly flammable materials. Smokeless powder is a typical fire hazard material. A fire involving smokeless powder in an above-ground magazine may cause the roof of the magazine to be lifted and the doors and windows to be blown out. A similar fire in an earth-covered magazine may blow out the doors and windows of the nonearth covered front wall. In either event, no substantial destructive effects to nearby buildings, as prescribed in OP 5, Volume 1, are to be expected.

Explosion Hazard Materials

Damage from explosion hazard materials is caused by concussion, blast, or sympathetic detonation. Prescribed distances between piles of these materials and between magazines containing these materials should be maintained in order to minimize the possibility of sympathetic detonation or propagation. Black powder and all high explosives are typical explosion hazard materials.

Missile Hazard Materials

Explosions involving explosive-loaded projectiles (or fixed ammunition) or ammunition components introduce a hazard not normally present in commercial explosives. This hazard is caused by missiles (flying debris) which may be propelled either as pieces of broken-up projectiles or complete projectiles, which may explode upon impact, or as a result of being heated by fire. The missile hazard distance is based on the limiting range of the majority of the missiles which might be projected from the type of ammunition involved. The missile distance varies with existing conditions; but under the same conditions, the distance is essentially the same for one as for many projectiles or components within each quantity-distance group of explosives. The distances prescribed in OP 5, Volume 1, are not to be lessened if the quantity of explosives to be stored is less than the maximum specified.

Inhabited Building Distances

Inhabited building distances represent the distances at which inhabited buildings will generally not undergo substantial structural damage. Inhabited building distances are designed to protect buildings against substantial structural damage, but window damages, shaking down of plaster, and possible damage from flying missiles are not considered as substantial.

ADVANCED BASE AMMUNITION HANDLING

A Chief Aviation Ordnanceman must be able to prepare for advanced base or forward area operations by estimating spare parts, supplies, equipment, and manpower requirements for aviation ordnance maintenance. In determining requirements for forward area or advanced base operations, it is necessary to consider the following:

1. Mission.
2. Environment.
3. Operating factors.
4. The availability of existing facilities.

A knowledge of the material and manpower requirements as listed in the Advanced Base Initial Outfitting Lists of Functional Components will be very helpful. The functional component is one of more than 300 standardized units of the system which the Navy has developed to enable it to build and operate its advanced bases in the least possible time and with a minimum expenditure of planning and logistic effort.

A functional component is a list of the requirements for the performance of a specific task at an advanced base, and consists of a carefully balanced combination of material, equipment, and/or personnel.

Each functional component is classified according to its primary function into 1 of 11 major groups, including aviation. Each major grouping is identified by letter designation and title; the functional components contained in each are identified by a combination letter, number, and title designation. The major group letter for aviation is H.

H components are designed to provide for maintenance, support, and operation of aircraft in an advanced area under combat conditions, and may be combined with other functional components to form several types of air stations.

Complete information and data are given in the abridged and the detailed outfitting lists for functional components.

It is only natural to suppose that in advanced areas there will not be the opportunity to afford ammunition proper stowage—stowage that is in accordance with doctrines established for ammunition depots and shore stations where permanent magazines are available. It is likewise reasonable to suppose that certain measures have to be taken to assure maximum protection of ammunition and personnel alike, even in advanced areas.

Vegetation should be controlled in magazine areas to reduce the fire hazard. When it is necessary to stow ammunition in areas where there is flammable grass, brush, weeds, leaves, or similar material, such material should be removed from the immediate confines of the magazine or open stowage site and for a distance of 50 feet from it on all sides.

In the initial conditions of occupancy of an area, it may be necessary to clear a stowage area by burning, since tools and equipment or chemical weed killing agents may not be available. After the site to be cleared by burning is selected, the area should be marked to show how much is to be cleared. If possible, a suitable firebreak should be cleared, by hand, around this area before it is fired. If handtools for clearing the firebreak are not available and the area to be cleared is small, water-soaked burlap, canvas, or other material should be placed around the area to prevent the spread of flames.

Operations involving the burning of flammable material should be closely supervised to prevent any general conflagration, and must not be undertaken after ammunition has been brought to the stowage site.

Combustible vegetation or other material must be removed from the top of earth-covered magazines within a 5-foot radius around each ventilator duct opening.

Any removal of flammable material or burning of dry local vegetation must, of necessity, be modified to conform with camouflage requirements and the need for emergency covering of ammunition piles. Burning of dry vegetation must not be carried out until after the area commander has been notified of the purpose, necessity, and extent, and he has given his consent for the operation. Extreme care must be exercised to prevent the smoke or flame from burning to reveal the position of a base to hostile observers or aircraft.

In some instances, native labor may be used in stevedoring operations, handling ammunition at stowage areas, building native-type structures for temporary shelters or coverings, and as common labor during the early stages of advanced base development. Precautions should be taken to prevent destruction of supplies and material through ignorance, negligence, or pilferage. When native labor is used for handling and stowing ammunition, the natives must be properly instructed about the particular hazards involved and must be supervised closely at all times.

The following regulations must be conspicuously posted on the inside of one door of each magazine or other building containing ammunition:

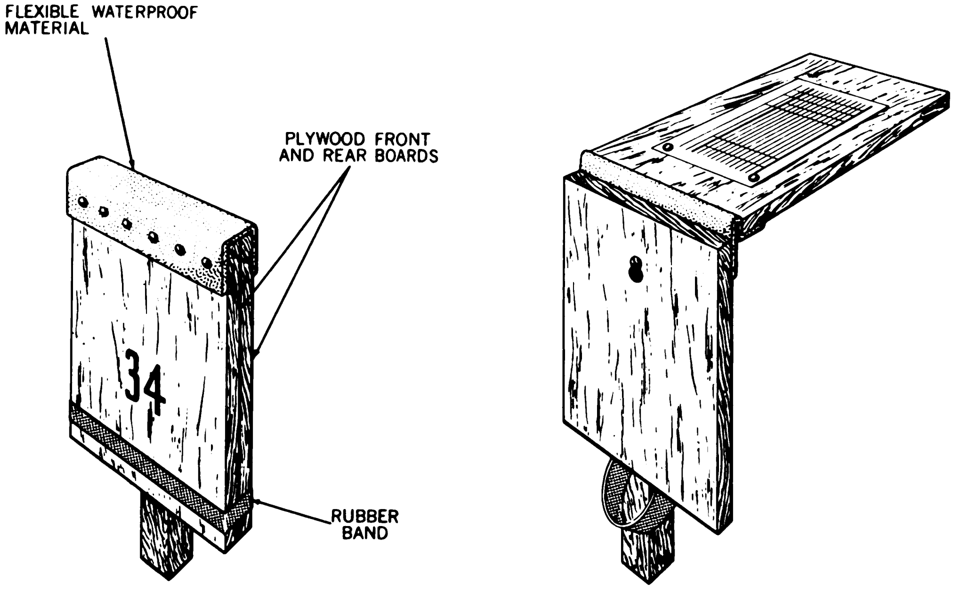
1. The hazard classifications of ammunition which may be stowed therein(explosive, fire, or missile).
2. The maximum permissible quantities of each hazard classification, determined from the quantity-distance relationships in OP 5, Volume 3.
3. Safety precautions and regulations pertaining to the specific material presently stowed in the magazine or building.

The information prescribed by the preceding paragraph should also be posted at each site of ammunition stowed in the open. For convenience and protection from weather, the information should be printed on a card and the card placed in a locally manufactured ammunition site sign and card holder. (See fig. 9-1.)

COVER AND PROTECTION

When selecting stowage facilities in advanced areas, it is important to take every possible advantage of natural cover for the protection of ammunition from the elements. In so doing, the extreme need for artificial cover is thereby lessened considerably. Ammunition necessarily stowed in the open requires certain precautions be taken in order to insure that it will perform satisfactorily at some subsequent date. It should be raised on dunnage at least 6 inches off the ground and the pile covered with tarpaulin of double thickness. For ventilation an airspace should be provided for between the tarpaulin and the ammunition.

Lacking sufficient tarpaulins to completely cover the ammunition to be stowed, use should be made of vegetation, broken packing cases, burlap bags, or any other materials which may serve the purpose of keeping the direct rays or the sun off and affording as much protection from rain as possible. Suitable trenches should be dug around each stack. This will serve to



CLOSED VIEW

OPEN VIEW

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Figure 9-1.—Ammunition pile sign and card holder.

prevent runoff rainwater from seeping underneath the dunnage. The nearest thing approximating a magazine for advanced base stowage of ammunition is a revetment or earth barricade. This device not only serves as a firebreak, but also as a shield against shrapnel from enemy bombs and in case of explosion of the dump itself, serves to deflect and absorb shrapnel which might otherwise set off a nearby dump.

In subtropical and tropical areas it may be impossible to maintain temperatures of the ammunition below the normal limits required. In this event it is imperative to make frequent inspections of the ammunition. Inspecting personnel should carefully test for excessive ether-alcohol fumes from smokeless powder tanks, look for TNT exudate on bombs and mines, and note any deterioration of pyrotechnic materials.

Ammunition containers should not be opened until the ammunition is required for issue or use, or when necessary for inspection or renovation operations. Ammunition removed from an airtight or watertight container, particularly in damp climates, may corrode and become unserviceable.

Security

Security procedures are necessary to protect stores of ammunition from persons who are unaware of the hazards inherent in ammunition as well as from any individuals who might contemplate detrimental acts. A security force capable of defending the area against light, hostile attack should be organized from personnel associated with ammunition stowing and handling facilities. Magazine areas should be guarded adequately at all times. Guards must know and understand the hazards of the material in the magazine area, and must be familiar with methods of fire reporting and firefighting.

SEPARATE STOWAGE

So far as possible, various ammunitions should be stowed separately. Further, sufficient distance should be left between adjacent piles of different types to prevent danger to one pile from destruction of another. There should always be sufficient space between stacks to provide walkways during inspections.

At advanced bases it is highly desirable to stow various calibers and types of ammunition together. However, the entire supply of each type or caliber should never be placed in the same stowage position for obvious reasons. The different types should be distributed between various stowages in such a manner that in no case will the entire supply of any one type or caliber be exposed in the event of fire or other hazard. Therefore, none of these, or any other instructions relative to segregation of ammunition, are to be so interpreted as to exclude the necessary dispersion of ammunition. They are held applicable to individual stacks in any one magazine or any one of several stowage areas existing at any one activity, not the entire supply at such activity.

Bomb Type Ammunition

Adequate stowage facilities are not available at most advanced bases for bomb type ammunition, as well as other types. It will nevertheless have to be stockpiled because of its importance to military operations. Since this is the case, it is necessary to observe certain precautions relative to exposed stowage. At permanent stowage facilities, forklift trucks, cranes, and other related handling equipment make easy work of moving and stacking ammunition. At advanced bases, handling equipment is usually scarce. Most likely, bombs will have to be moved about or stacked manually, The bombs that are stacked by hand will normally be 500 pounders or under. Heavier stores will have to be rolled into position in lines leaving enough space between rows in which to walk and work.

It is possible to stow general-purpose, fragmentation, semi-armor-piercing, demolition, and depth bombs in the open unprotected from the elements for short periods of time without major impairment of their operational efficiency. The inventory of ammunition at an advanced base may include various stores containing batteries. This type of ammunition cannot be exposed to the direct rays of the sun. It must be covered with anything available to keep the items shaded. It is also imperative to protect from the sun's rays all incendiary bomb clusters in containers.

Time should be taken during inspection of bomb ammunition at advanced bases to tighten all caps, plugs, and other attachments found to be loose. This especially applies to fuze cavities in the bombs. A coating of grease should be placed at the junction of the fuze-hole plug and the bomb body after tightening the plug to keep out moisture. Ammunition received at advanced bases will quite often be found with loose fuze-hole plugs; even missing in some instances. Every effort should be made to procure and install these plugs where missing. If this is impossible, wooden plugs should be cut to fit and installed until standard plugs are obtained. All threaded sections of the bombs should be coated with grease. Nose and tail fuzes and suspension lugs will screw in smoothly if grease is used to protect threads from corrosion. Bomb fuzes and boosters must not be allowed to become adrift and abused. This may render them unreliable and unsafe, creating an explosive hazard in the area. With the nonstandard stowage methods to be found at advanced bases, it may be expected that ammunition components may more easily become adrift than at permanent magazines. Consequently, a closer watch should be maintained to guard against such possibilities.

Stowage of bombs in the open necessitates that they be piled or lined up horizontally on level dunnage to prevent their falling or rolling and striking others nearby. They should never be stood on end or leaned against any form of support. Stowing bombs on ground areas requires that they be supported by relatively thick dunnage to form an adequate airspace between them and the ground. Logs may be split and used for dunnage. Where the ground is soft, it may be wise to use the whole log (not split) to minimize settling of the dunnage. Bombs of different types held in reserve should be stowed in separate revetments or dumps if at all possible. Completely assembled bombs should never be stowed with unassembled bombs. However, it is a good idea to stow crated tail vanes for any stock of bombs with the bomb bodies. This will facilitate supply of both items.

Bombs returned unused from missions, or those assembled and not used, may be left assembled, but they must be defused. These should then be stowed one layer deep on dunnage, with tails alternately pointing in opposite directions, near the aircraft loading area. Tail vanes, due to their sheet metal construction, are more susceptible to damage than bombs themselves. Therefore, it is best to leave them in their crates until they are needed.

Rocket Type Ammunition

Most aircraft rocket type ammunition (rockets and missiles) is shipped disassembled. Warheads, motors, guidance systems, and fuzes are shipped separately. One fundamental rule in rocket and missile handling and stowing is that they should never be fully assembled except just prior to issue for use. Their components are placed in segregated stowage and, as far as practicable, separate from other types of ammunition. At advanced bases where space may be limited, it is permissible to stow rockets and missile motors with smokeless powder charges, the warheads with projectiles, and the fuzes with bomb type fuzes. In this event, all other safety precautions must be observed and care is to be exercised in issuing these components. Rocket fuzes are issued in metal containers and the same precautions should be observed as with bomb fuzes.

Rocket and missile motors require special handling not afforded any other type of ammunition. They might even be called delicate and sensitive in the extreme. Ignition of their propellent charge, or grain, is accomplished by an electrical impulse transmitted through wires to their igniters through the surface of the motor. Corrosion cannot be allowed to build up on these surfaces. In cleaning off any corrosion, sandpaper (fine) may be used, but not wire brushes or emery cloth. The last two items might possibly cause production of sufficient static electricity to set off the black powder igniter squib. Rigid precautions have to be taken to insure that rocket and missile motors are not stowed or allowed to be passed near such energy producing components of electronic gear as antenna lead-in wires, high voltage electric circuits, and radar magnetrons. These components may cause the motors to ignite through radiated electrical energy.

Contact surfaces and threaded sections of rocket components should be preserved with a light coating of mineral grease to prevent corrosion, especially while stowed at advance bases. Any component that has been corroded, damaged, or dropped forcibly enough to possibly break the propellent grain should be set aside and not used. The motors are highly sensitive to moisture. As a result, they should at all times be stowed under cover upon suitable dunnage.

Stowing a completely assembled rocket or missile unless designated to be so stowed is the same as stowing a loaded gun. As a consequence, they are normally never assembled into complete rounds until immediately before use unless the tactical situation dictates otherwise. When assembled, complete rounds should be stowed only in ready service lockers or in revetments, behind shields and barricades, and other equally safe locations. Unassembled motors are chiefly fire hazards due to the relatively unconfined condition of the propellant grain.

Missiles and rockets may not be fired if the propellant temperature is below or above the temperature limits stenciled on the motor. In temperature extremes, the motors will have to be stowed in proper locations for 6 or more hours for the propellent temperatures to stabilize within these two figures. A temperature insensitive motor propellant is now replacing present inventories and should simplify the handling and stowage problems connected with missiles and rockets.

Pyrotechnics

Pyrotechnics are more subject to deterioration than some other types of ammunition. Some pyrotechnics are susceptible to spontaneous ignition if exposed to moisture, high temperatures, or rough handling.

Pyrotechnics are in general a fire hazard. Numerous substances of varying stabilities and sensitivities are used in their manufacture to produce the effects required. Amongh these are nitrate mixtures, which are fairly insensitive, and chlorate mixtures and mixtures containing red phosphorus, which are very sensitive. Mixtures containing chlorates and sulfur are susceptible to spontaneous ignition. Some parachute flares contain a magnesium-oxidant composition that burns to produce extremely high temperatures. Once ignited these flares can be extinguised by the utilization of a low velocity fog applicator.

Pyrotechnics should be stowed in the moisture proof and hermetically sealed containers in which they are supplied. They should be stowed alone in accordance with the Chart of Permissible Storages (appendix A, of OP 5 Vol. 3). Water-activated pyrotechnics should be stowed by themselves. However, they may be stowed near the door of magazines or buildings used as magazines containing other types of pyrotechnics provided that the water-activated items are physically separated from the other items. Water-activated pyrotechnics should be suitably placarded to indicate that no water is to contact them. Carbon-dioxide type fire extinguishers to combat fires involving water-activated pyrotechnics should be kept near the containers and conspicuously marked as to their intended use.

Owing to the multiplicity of types of pyrotechnics and the unavoidable hazard due to the unknown condition of the many compositions and types, pyrotechnics should be dispersed into several stowages, where practicable. Pyrotechnics should be separated according to type, color, and lot number. Boxes containing signal cartridges discharged by percussion primers should be placed flat with the top up.

Photoflash bombs are readily subject to explosion, since they are extremely sensitive to heat, shock, and sympathetic detonation. They should be stowed separately from all other types of ammunition and protected as much as possible from bomb and projectile fragments, machine gun and rifle fire, and the detonation waves of nearby explosions. Not more than 1,000 photoflash bombs should be stowed in any one space. Magazines and open areas containing photoflash bombs should be separated by the same distances as those prescribed for high explosives.

Photoflash cartridges are loaded with the same materials as photoflash bombs and are subject to the same stowage and quantity-distance regulations, except that the maximum permitted quantity in any one magazine is 500,000 pounds gross weight of composition and containers combined. The actual amount of pyrotechnic composition should not exceed 143,000 pounds net.

All pyrotechnics should be afforded as much protection from the elements as is available to insure a maximum of satisfactory performance.

Missile Protection

Guided missile components are shipped and stowed in moisture proof containers which simplify handling and stowage at advanced bases. Protection from extreme temperatures is the main consideration in stowage. Warheads are stowed as high explosives, solid propellent motors as rocket motors or smokeless powder, and tracking flares are stowed as pyrotechnics. Guidance and control sections, wings, and canards may be stowed as inert material. For information on liquid propellants, see OP 3199, Handling and Storage of Liquid Propellants.

SAFETY PRECAUTIONS

In the handling and stowing of all types of ammunition, a need for rigid adherence to all safety precautions is mandatory. Although safety precautions have been written on almost every apparent situation dealing with all types of explosives, ammunition, and handling equipment, the Aviation Ordnanceman will undoubtedly be faced with new and unwritten experiences each time ammunition is handled or stowed.

GENERAL

One of the first general precautions to be remembered is that when there is the slightest doubt as to the exact meaning of a particular safety precaution pertaining to ammunition, an interpretation should be requested from NavOrdSysCom. The method of communicating with the Command is determined by the seriousness of the situation. If unsafe conditions or unusual situations are encountered, for which no safety precautions are written, the commanding officer will find nothing in any of the safety precautions or regulations which may be construed as authority to continue operation under the existing situation. He must either cease operations entirely, or hold further operations in abeyance until advice can be received from NavOrdSysCom.

Safety devices provided for handling and stowage of ammunition are to be used consistently without fail. These devices must be kept in good order and operative at all times. They are there for the protection of all hands. Further, all operating instructions for such equipment must be diligently followed.

Changes, modifications in, or additions to ordnance material are not made without explicit authority from the Command or Commands concerned. No ammunition or explosive assembly will be used in any gun or device for which it is not designated.

Familiarity with any line of work, no matter how dangerous, is apt to lead to carelessness. Personnel supervising or performing work in connection with the inspection, care, preparation, use, or handling of ammunition and explosives must exercise the utmost care that all regulations and instructions are rigidly observed. Inexperienced personnel require close supervision and should be frequently warned of the necessity of using the ultimate precaution in the performance of their work. No relaxation of vigilance should be permitted.

SPECIFIC

All ammunition, explosives, and powder should be protected from abnormally high temperatures. If so exposed to abnormal temperatures they must be handled in strict accordance with the latest NavOrd Instructions. NavOrdSysCom prescribes the maximum allowable storage temperatures for all types of ammunition.

Smokeless powder which has been wet from any cause whatever must be considered dangerous and is handled as prescribed in OP 5. Also, smokeless powder which shows unmistakable signs of advanced decomposition is disposed of according to current instruction.

In order to minimize the dangers of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition is handled as little as possible. Denting of thin-cased high explosives has caused detonation of the explosive in some instances.

Any fuzed projectile dropped from a height of 5 feet or over must be returned, if practical, to the nearest naval ammunition depot. If not, it should be disposed of as prescribed in current instructions.

Magazines must be kept scrumpulously clean and dry at all times. Explosives, containers and authorized magazine equipment only should be stowed in magazines. The removal and/or disposal of oily rags, waste, or other foreign materials susceptible to spontaneous combustion in magazines is mandatory.

Naked lights, matches, or any other spark or flame-producing device must never be taken into magazines or other spaces used primarily as magazines as long as the spaces therein contain explosives. Before performing any work which might cause either an abnormally high temperature or intense local heating in a magazine, all ammunition must be removed to safe stowage until normal conditions have been restored.

Black powder is one of the most dangerous of explosives and must be kept by itself. Only such quantities as are immediately needed should be broken out of the magazine. A container of black powder should never be opened in any magazine, nor in the vicinity of a container in which there is any explosive.

Ammunition must not be altered, nor should fuses or any other parts be disassembled without explicit instructions from NavOrdSysCom.

Ammunition must be handled under the direct supervision of qualified personnel who understand thoroughly the hazards and risks involved. Personnel handling ammunition must be impressed with the fact that their safety, as well as that of others, depends upon the intelligence and care exercised by themselves and their shipmates.

The handling of ammunition should always be conducted so that a limited number of personnel are involved—the smallest number compatible with the work to be accomplished.

Charges of static electricity can be accumulated on a person and on explosive materials such as smokeless powder. The discharge of static electricity is a serious hazard in the presence of certain exposed explosives, dust and air mixtures, and flammable vapor and air mixtures. Processing equipment for such materials subject to static discharge should always be grounded.

Workbenches should be covered with electrically grounded conductive materials as should be the decks wherever possible. Safety shoes which will not cause sparks should be issued to all personnel performing certain types of ammunition overhaul and maintenance work. Cushioned metal chairs may generate static electricity under certain atmospheric conditions; they should not be used around ammunition and explosives.

Drivers, both Navy and civilian, engaged in the operation of Navy vehicles carrying explosives must understand that during the time they are operating such vehicles, they bear responsibility and personal liability as agent of the Navy for any damages resulting from their negligence. This applies both to their driving and improper operation of their vehicles. (See OP 2239, Drivers Handbook Ammunition, Explosives, and Dangerous Articles.)

The driver is required to carry with him, while driving, his medical certificate (or photostat of same), and is responsible for keeping his certificate current by submitting to reexamination at specified intervals appropriate to his age group. It is the duty of the driver of a truck loaded with dangerous cargo to be certain that proper dangerous cargo placards have been affixed to his vehicle in the specified locations prior to his departure for an off-station trip.

GENERAL FIREFIGHTING PROCEDURES

The prevention and the control of fires at ordnance establishments require more than willingness and main strength. A broad range of highly combustible materials including explosives are present; and to combat successfully fires involving these substances, it is necessary that the personnel understand thoroughly what a particular kind or class of explosive or ammunition will or may do when subjected to heat or flame. This section outlines firefighting procedures for the various types of fires which may be encountered. For assistance in determining firefighting equipment requirements, consult OpNavInst 11320.11 (Series) and OpNavInst 11320.15 (Series).

Forces engaged in fighting fires involving explosives and ammunition must always seek such cover as is available and never expose themselves unnecessarily to the intense heat, flying fragments, or possible explosions. When the fire chief and the person in general command of fighting the fire are in agreement on the procedure, firefighting forces may approach a fire to extinguish it or protect adjacent buildings. Where high explosives are involved, this decision is contingent upon one or both of the following conditions:

1. It must be known that a considerable distance, a barricade, or a dividing wall of masonry or concrete separates burning nonexplosive materials from high explosives.
2. If a primary explosion has already occured, it must be known that only the heat of the burning wreckage menaces other buildings, regardless of their contents.

When there is any doubt about the accuracy of information regarding a fire involving explosives, no effort should be made to fight it and safe distances or shelter for men and equipment must be observed until the nature and condition of the fire are determined. Getting this information rapidly is particularly critical where fire follows an explosion and the lives of injured people trapped in buildings may depend on the rapidity with which the work of the firefighting forces is done.

When any person discovers a grass or brush fire within or approaching magazine areas, he must immediately give the alarm unless the fire is small and he is positive that he can extinguish it alone, in which case he should attack the fire at once. Firefighting in grass or brush must be conducted vigorously even though the fire may be immediately adjacent to or actually over but not penetrating into a magazine.

Local and state or federal forest service officials should be consulted with respect to periods of greatest danger of forest and grass fires in the vicinity. During these periods, additional fire protective measures, if so indicated, should be taken, including expanded fire watch, extra equipment, and repair or establishment of firebreaks.

When employees are present in a building or open magazine and a fire occurs in or around the structure, the fire must be reported immediately. Personnel must attempt to extinguish the fire using the suitable first-aid firefighting equipment available to the building or magazine. However, if the fire is in explosive material or immediately endangering it or if the fire is so large that it cannot be extinguished with the equipment at hand, the magazine or building should be vacated.

Closed magazines from which smoke is issuing, or which give other evidence of an interior fire, must not be opened pending the arrival and decision of the commanding officer or his authorized representative.

SPECIFIC FIREFIGHTING PROCEDURES

The firefighting procedure to be followed in a magazine or building containing ammunition or explosives depends on the color-hazard background painted on the structure. If there is a temporary color-hazard placard, firefighting procedures indicated by the temporary color take precedence over those specified for the permanent color background. The type of material represented by each color-hazard background is described in OP 5 (Vol. 1) and table 9-1 of this chapter.

A card indicating the firefighting instructions for each background color should be in each fire truck, readily available to firefighting personnel.

Yellow Color-Hazard Background

Ammunition and explosives of this category usually detonate when involved in fire, and mass detonation can be expected. If a fire occurs in a magazine containing ammunition and explosives of this category, personnel that are present must attempt to put the fire out with such equipment as may be at hand, provided that the fire has not reached the explosive material and there appears to be a good chance of putting the fire out with the equipment at hand. Otherwise, personnel must evacuate the magazine, sound the fire alarm, and take cover. When a fire has reached the explosive material, the firefighting forces must limit their operations to preventing the spread of the fire and protecting the adjacent buildings. Under these conditions, personnel should not approach closer than 500 feet nor should fire engines or other apparatus be brought closer than 1,000 feet to the fire.

Red and Yellow Striped Color-Hazard Backgrounds

Limited explosions and, to a certain extent, light missiles may be expected from a fire involving materials of this category. Personnel discovering a fire involving ammunition or explosives of this category should give the alarm and attempt to put the fire out with the material at hand, provided the fire is in the incipient stage. When the firefighting organization arrives, the fire should be fought if it appears that it will be possible to put it out. If this is not possible, the building should be abandoned and firefighting efforts concentrated on preventing the spread of the fire. Personnel should exercise due precautions to prevent injury to themselves and their equipment from missiles.

Red or Green Color Hazard Background

Heavy explosions and a scattering of missiles may be expected from a fire involving materials of this category. Every effort must be made to prevent a fire from reaching this class of material. If a fire occurs in a magazine containing ammunition and explosives of this category, personnel that are present must attempt to put the fire out with the equipment at hand, provided that the fire has not reached the material itself and there appears to be a good chance of putting the fire out with equipment at hand. Otherwise, personnel must evacuate the magazine, sound the alarm, and take cover. When a fire has reached the explosive material, the firefighting forces should limit their operations to preventing the spread of the fire and protecting the adjacent buildings. In this case, firefighting personnel should not approach closer than 500 feet nor should fire engines or other apparatus be brought closer than 1,000 feet to the fire.

Blue Color-Hazard Background

Fires involving materials of this category give rise to heat so intense that it is dangerous to the personnel and equipment in the vicinity of the fire. Personnel in the immediate vicinity of a fire involving ammunition or explosives of this category must do everything possible to activate deluge systems and give the alarm without exposing themselves unduly to the intense heat. In magazines containing such ammunition or explosives, personnel should attempt to put out an incipient fire with the equipment at hand if control of the fire appears possible. Unless the fire is of a minor nature or there appears to be a good chance of controlling it, the firefighting organization must confine its operations to preventing the spread of the fire to other buildings.

White, White and Yellow Striped, Brown, or Black Color-Hazard Background

Materials of this category represent fire hazards. Personnel who discover a fire involving such ammunition, explosives, or inert materials must give the alarm and fight the fire with the materials at hand until help from the firefighting organization arrives. Water should be used unless it is known that the only material involved is water activated. Such fires, unless they involve packaged water activated (Group C) chemical ammunition with fuze or booster installed, must be fought until they are brought under control.

When a fire becomes uncontrollable in a magazine containing packaged Group C chemical ammunition with fuze or booster installed, the magazine must be abandoned and firefighting efforts confined to saving adjacent magazines. Fires involving Group C chemical ammunition that is unpackaged, unfuzed, or without a booster may be fought until they are brought under control. Due to the great amount of smoke liberated, there is an extra hazard of men becoming lost in the magazine while attempting to fight the flames. Men with portable extinguishers should not be permitted in the magazine after a fire gains headway.

Personnel that handle aviation ordnance of any type are required to be qualified and certified in accordance with OpNav Instruction 3571.3, Aviation Ordnance Qualification and Certification Program. This program was discussed earlier in chapter 2 of this manual.

CHAPTER 10

AIRCRAFT BORESIGHTING

THEORY OF BORESIGHTING

The purpose of boresighting aircraft armament is to establish a relationship between the flight attitude of the aircraft, the bores axes of the armament, and the axis along which the sighting is projected. The theory of boresighting involves analyzing pertinent ballistics and mechanical data in establishing the relationship between the sight line of the aiming device (sight) and the trajectory of the projectile being fired or launched in order to predict its mean point of impact at predetermined ranges. No sighting device can do its job accurately unless it is properly alined with the armament with which it is used. Thus, the sight and armament must be made to function together. The technique of making them function together is called boresighting.

Aircraft guns are boresighted so that their axes of fire either converge or remain parallel throughout the trajectory. There are tactical advantages to be gained in both of these boresight methods. When the guns are boresighted to converge at some point along the axis, a more concentrated fire will exist at this point, thereby producing a more deadly fire when the target is at the point of convergence. When the guns are boresighted so that they are parallel to each other, their concentration will be the same throughout the entire range of the guns. Thus, the ''lethal density'' of the concentration is the same at all points within the range of the guns.

Modern high performance aircraft have their guns mounted in the wing roots or the fuselage. Installations in which the guns are mounted in the fuselage normally use parallel boresighting. However, the final decision as to how they are to be boresighted is controlled to a great extent by their intended tactical employment and by the needs and desires of the operating activity.

BORESIGHTING TERMINOLOGY

To facilitate understanding of the theory and practice of boresighting, the terms used in connection with boresighting are defined below:

1. Armament datum line–A longitudinal line established on or within the aircraft by the manufacturer, having a fixed relationship to the angle of attack of the aircraft.
2. Datum point–A definite point on the boresight screen or target where the line of sight through the boresight alinement sight will strike, when the aircraft is properly alined with the boresight screen or target. Its position with regard to the centerline is given in the Maintenance Instructions Manual for each specific aircraft.
3. Boresight datum line–An imaginary line through the boresight fixture to the datum point on the target screen. The boresight datum line may or may not be parallel to the armament datum line, depending on the model of aircraft.
4. Angle of attack–The angle of attack and the boresight datum line of the aircraft are intimately associated. When the aircraft has been set up or positioned so that the datum line (or the datum line sight depending on the specific model of aircraft) is horizontal, the aircraft may be said to have assumed its proper angle of attack for boresighting. This is true only because the manufacturer has previously computed the angle of attack, with the aircraft under a definite set of conditions which are deemed to be the optimum for a particular flight condition (combat condition). When the aircraft is leveled and boresighted, its boresight datum line and the angle of attack are in such relationship to each other that projectiles will strike the target at the specified range under the conditions mentioned. If the conditions of altitude, gross weight, angle of dive, acceleration of gravity, and airspeed are changed to values other than those set

up as the optimum, corrections will have to be made. In most operational aircraft, these corrections are made automatically in the fire control system.

5. Flight attitude–This is the position of the aircraft while airborne in normal unaccelerated flight. Normal flight is the condition that exists when the aircraft is in level flight, is at its critical altitude, is flying at V max (average combat speed), is under full military power, and has a full military load and one-half its total fuel capacity.

6. Flight line–This is the line in space along which the aircraft is moving.

7. Zero sight line–The sight line through the fixed pipper of the sight which is parallel to the armament datum line.

8. Line of sight–The straight line from the eye to the object observed.

9. Sight angle–The angle between the zero sight line and the line of sight at the instant of firing or releasing. For a zero sight angle, the line of sight will be through the fixed pipper of the sight. Sight angle may be positive or negative. It is positive when the zero sight line is above (beyond) the impact point, and negative when the zero sight line is below (short of) the impact point.

10. Sight axis–The straight line from the pilot's eye through the fixed pipper which extends out into space.

11. Impact point–The point at which the projectiles or missiles will strike the target in a correctly solved fire control problem.

12. Bore axis–A straight line through the center of the bore of the gun (from chamber through muzzle) which extends out into space.

13. Bore line–The line in space along which the bore axis of a gun is projected. This line is established by the boresighting procedure.

14. Mean point impact (M. P. I.)–The average point of projectile impact from a gun where the heaviest density is registered.

15. Point of convergence–The point at which the bore axis of two or more guns intersect or converge. It also may be the point at which the sight line and the bore axis intersect.

16. Dispersion–The spread of projectiles from each gun due to muzzle whip and other ballistic factors.

17. Lethal density–The concentration of projectile impact density within a given area.

18. Trajectory–The actual path described by the center of gravity of the missile or projectile in free flight through space.

19. Launcher line–The longitudinal axis of the rocket or missile while fixed in the launcher.

20. Parallax–The apparent displacement of the position of an object caused by a shift in the point of observation.

21. Allowance for parallax–A correction to the sight made by adjusting the mount to change the sight angle to compensate for the fact that the sight is above the gun, rocket, and missile launcher, or bomb station.

22. Target screen–A fixture having separate aiming points for sights, individual guns, camera, and datum sights. It may be designed for use at any given distance in front of the aircraft. These screens may be painted on plywood, fiberboard, screen, hangar doors or bulkheads. They are normally designed for use at distances of from 10 to 300 yards.

23. Parallel boresighting–Alinement of all the armament of an aircraft and its gunsight so that the bore axes and the line of sight are parallel–parallax not considered.

24. Convergence boresighting–Alinement of all armament of an aircraft and its gunsight so that the bore axes and the line of sight converge at some predetermined range or ranges, parallax not considered. (NOTE: Combinations of parallel and convergence boresighting may be used. For example, the bore axis of the guns may converge in the horizontal plane but be parallel to the sight axis in the vertical plane.)

25. Point boresighting–The point on the zero sight line to which the guns are boresighted. This type of boresighting is covered by instructions provided in the Maintenance Instructions Manual for the aircraft involved.

26. Mil–An angle whose tangent is 1/1,000, or an angle of 1 mil subtends 1 inch at a distance of 1,000 inches.

27. Datum sights (also called boresight brackets and target alinement sights)–These alinement sights may be ring and post, telescope, or ring and peep sights. When installed in the aircraft they are used to establish the correct line of sight (in relation to the armament datum line) between the aircraft and the boresight target. Some of these sights are adjustable, thus allowing for armament boresighting at different degrees of depression or elevation. In some installations the adjustment may be used to aline the boresight target with the lateral attitude of the aircraft making leveling of the aircraft unnecessary.

28. Leveling lugs–Lugs or blocks built into the aircraft by the manufacturer and designed

to be used with a spirit level or quadrant when leveling the aircraft for boresighting.

29. Leveling datum plate—A plate having lateral and longitudinal reference marks for use in leveling the aircraft with a plumb bob.

30. Plumb bob bracket—A bracket to which the plumb bob line is attached.

31. Projectile clearance gage—A tool for checking for sufficient clearance between the projectile path and the aircraft structure to insure that the projectiles will not strike the aircraft.

CONVERGENCE BORESIGHTING

For such tactical employment as ground strafing, it may be more effective to boresight the guns to converge at some point in range, thus giving more spread of gunfire at points in front of the point of convergence. In convergence boresighting, all guns are alined to fire to a certain point along the sight axis. This may be whatever distance is established by doctrine. The lethal density at this point in the trajectory is greatly magnified.

Each individual gun has its own dispersion due to muzzle whip or jump. This jump or whip is due to several factors—among which are the lack of rigidity of the long barrel, lack of rigidity of the gun mounts, and the fact that the barrel tends to elevate itself when the gun fires. Guns that are boresighted parallel have greater total dispersion than those which are boresighted to converge at a point. The effects of dispersion are less conspicuous in the guns which are boresighted to converge. Also, if one of the guns is not in proper boresight, the loss of its effectiveness will not be as great for convergence boresighting.

PARALLEL BORESIGHTING

Parallel boresighting (infinity boresighting) is used on installations where the guns are closely grouped in the fuselage. This type of boresighting produces a highly effective lethal density along the entire trajectory up to the maximum range of the guns.

EQUIPMENT USED IN BORESIGHTING

Boresighting kits are usually composed of only the necessary equipment and accessories to perform a particular task of the boresighting process. The kits may be roughly divided into two distinct classes—kits for a specific equipment (20-mm guns, cameras, etc.) and kits for different model aircraft. The latter may contain datum sights, mount tools, projectile clearance tools and other items necessary for use in conjunction with equipment kits to boresight aircraft.

BORESIGHTING KIT MK 3 MOD 0

Aircraft Machine Gun Boresighting Kit Mk 3 Mod 0 is used for boresighting 20-mm aircraft guns in present gun installations. The principle of operation of the kit is based upon forming a telescope by inserting the breech and muzzle fixtures in a gun barrel. A telescope is formed with the barrel of the gun acting as the tube of the telescope. The telescope thus formed utilizes the last few inches of the barrel's muzzle end making extremely accurate boresighting possible.

The focal length of the boresighting kit is dependent upon the length of the gun barrel and the adjustment of the eyepiece; consequently guns with short barrels cannot be boresighted with the Mk 3 Mod 0 kit. However no shortbarrel guns are in use at present.

A cutaway 20-mm Aircraft Gun Mk 12 with boresighting equipment installed is shown in figure 10-1.

Detailed procedures for boresighting guns installed on aircraft are outlined in the appropriate Maintenance Instructions Manual prepared by NavAirSysCom for the specific aircraft. These instructions include armament harmonization and necessary boresighting measurements for local manufacture of target screen and the relative locations of the target screen and the aircraft.

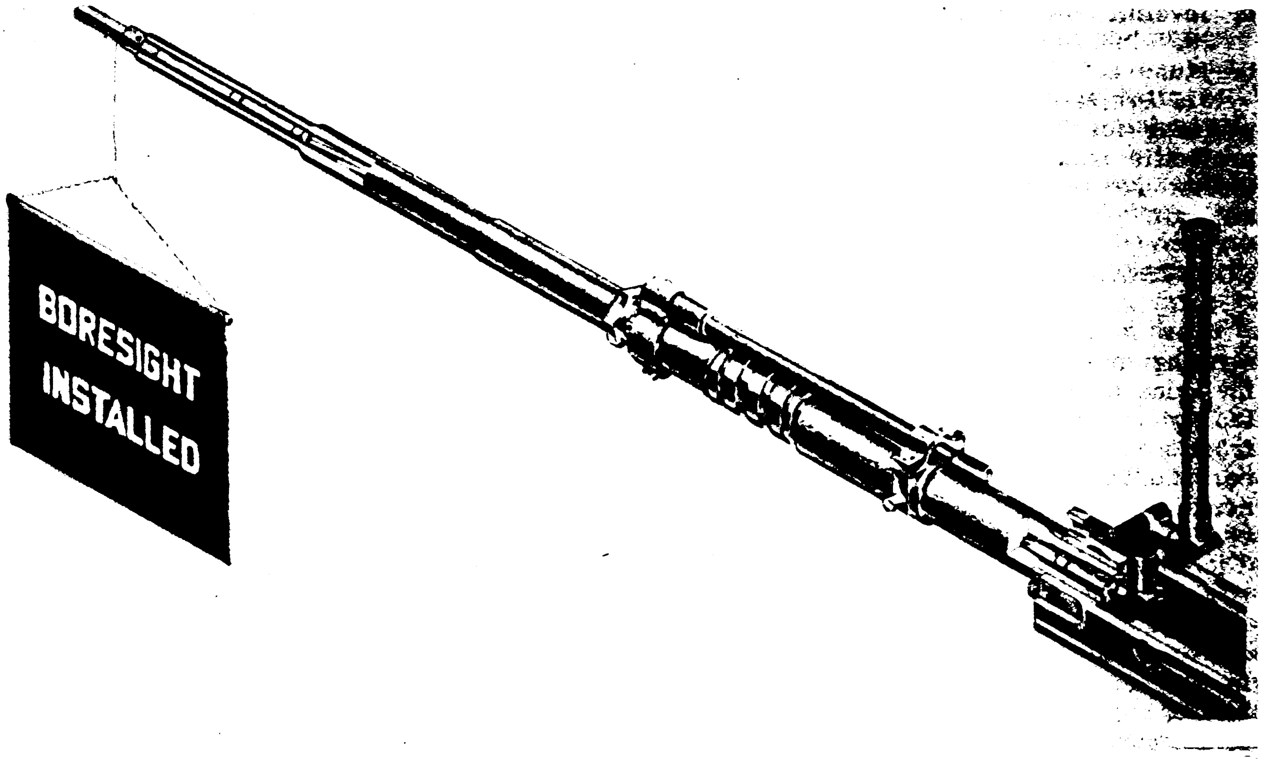
Components

The boresighting kit contains the following items:

1. Breech end assembly.
2. Breech adapter.
3. Muzzle end assembly and warning flag.
4. Installation tool and tool extension.
5. Carrying case.

The carrying case and contents are shown in figure 10-2.

MUZZLE END ASSEMBLY.—The muzzle and assembly (fig. 10-3) has a fixed crossline lens, an objective lens, and an eccentric mount which is adjustable for collimation at time of manufacture.



AO.563

Figure 10-1.–20-mm Aircraft Gun Mk 12 cutaway showing installed boresighting equipment.

The assembly carrying the objective and crossline lenses is inside of and keyed to an expanding barrel. The unexpanded diameter position is marked by an index line on the key and the barrel (fig. 10-4). This barrel slides freely into the gun barrel, where it is expanded by the installation tool.

INSTALLATION TOOL.–The installation tool (fig. 10-5) consists of a rod inside a sleeve, each knurled at the handle end, and having a projecting pin at the opposite or engagement end. To provide additional handle length for less accessible gun barrels, the handle has an extension which attaches to the tool and has knurled handles identical to those on the tool.

BREECH END ASSEMBLY.–The breech end assembly (fig. 10-6) consists of the erector lens, three mirrors, a dove prism, the eyelens, and a window arranged within their housings to form the optical system of the breech end assembly. The mirror housings are fitted together in such a manner that the 360-degree rotation between the housings make it possible to place the eyepiece in almost any desired position. The dove prism mount carries the eye guard and window on its upper end while its lower end is attached to the focusing tube in such a manner that the mount and prism assembly may be rotated 360-degrees for the purpose of orienting the reticle pattern and target screen.

The focusing tube is prevented from rotating and kept within focal limits in the eyepiece tube by a setscrew which extends through the eyepiece tube and into a vertical slot in the focusing tube. A lockring mounted on the eyepiece tube prevents free movement of the focusing tube once the desired focal length is attained.

The breech insert end of the Mk 3 Mod 0 kit is designed to fit the chamber of guns using percussion primed ammunition. A breech adapter (fig. 10-7) is furnished with the kit for

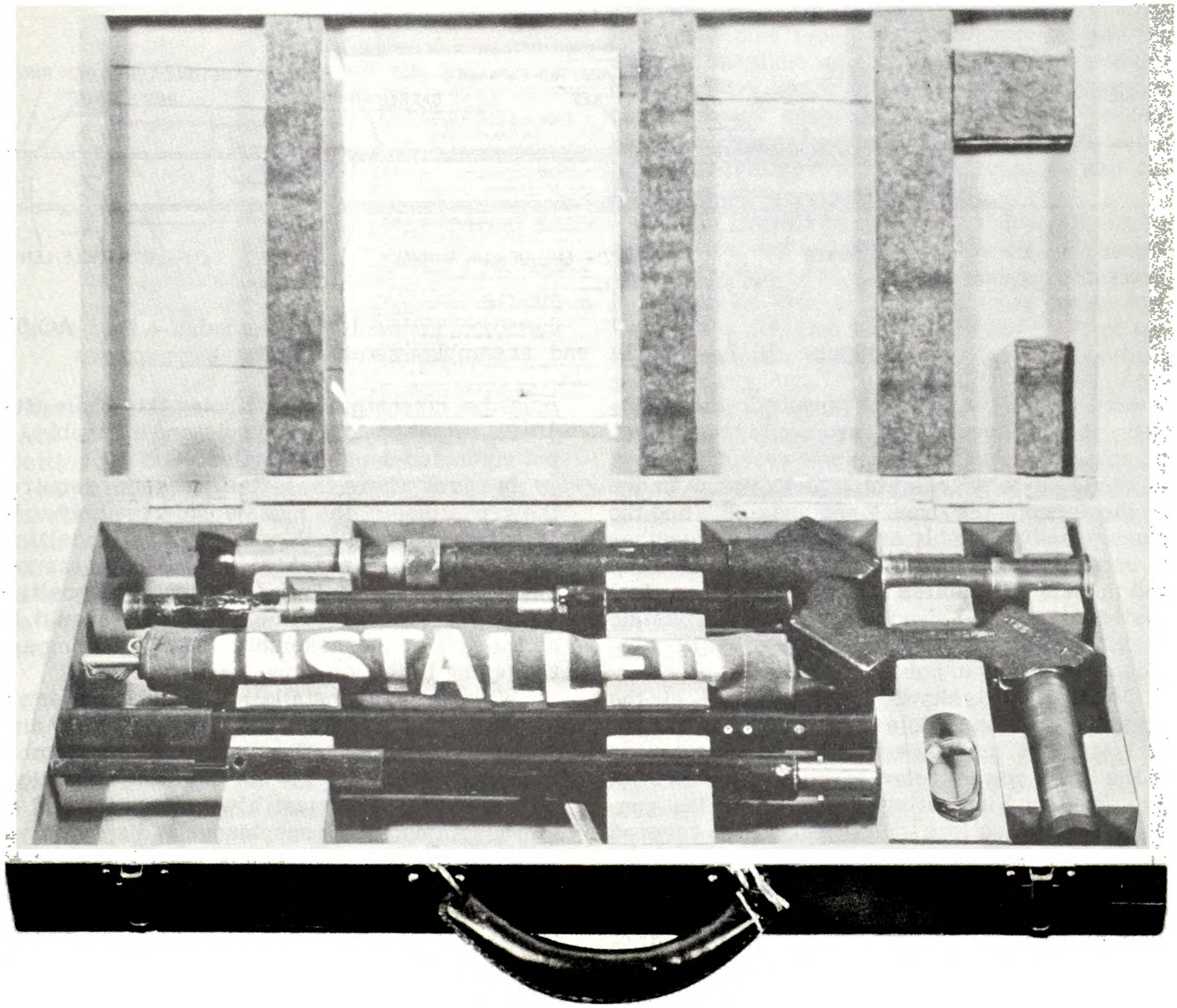


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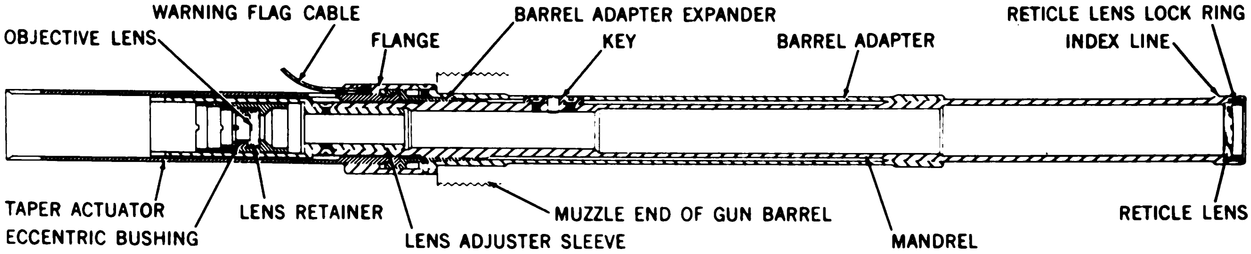
Figure 10-2.—Boresighting Kit MK 3 Mod 0 assembled in carrying case.

use when boresighting MK 12 guns. This adapter is shown installed on the breech assembly in figure 10-6.

Both the muzzle and breech assemblies are assembled using gaskets, seals, and close fitting parts to keep out moisture and dust. For this reason protective caps are provided in the kits. These caps should be used at all times when the assemblies are not in use.

Using the MK 3 Mod 0 Boresighting Kit

The muzzle end assembly (fig. 10-3) if properly installed, establishes the axis of the last 5 1/2 inches of the gun bore. These last few inches have the most effect on the flightpath of a projectile. The use of this boresighting system results in obtaining an optical line projected



AO.565

Figure 10-3.—Muzzle end assembly—section view.

toward the target which is tangent to the flightpath at the instant the projectile leaves the muzzle. The breech and muzzle assemblies are, in effect, a telescope which picks up the image of the target. The breech end assembly and the muzzle end assembly are always used together in boresighting. When used together, the breech and muzzle assemblies form a complete optical system (fig. 10-8), consisting of a crossline presentation in which the intersection is coincident with the gun bore centerline.

Figure 10-8 shows the conditions of the crosslines of the reticle in the muzzle assembly in alinement and superimposed on the center of the mark on the target board as seen through the eyepiece, indicating alinement of the gun. Detailed instructions on alinement are covered in the NavAir Manual for the specific aircraft.

Before installing any part of the boresighting kit, the gun barrel must be thoroughly cleaned.

Rotate the taper actuator end (fig. 10-3) of the muzzle end assembly counterclockwise until the index mark on the key is in alinement with the index mark on the adapter body (fig. 10-4). This insures a nonexpanded assembly for easy insertion into the gun bore.

Attach the installation tool to the muzzle end assembly by engaging both the inner and outer pins in their respective slots. Attach the tool extension if needed.

Insert the muzzle end assembly with the attached installation tool into the gun muzzle and expand by holding the inner part of the installation tool and rotating the outer part clockwise until firmly installed in the gun bore. Care must be taken that the warning flag chain (fig. 10-9), attached to the muzzle end assembly, is not entangled during insertion.

In cases where the installing agency requires the crosslines of the muzzle end assembly to be oriented in a vertical and horizontal position, an index line is provided at the end of the assembly on the mandrel to indicate the position of the vertical crossline. This line should be at the top of the assembly when inserting and tightening in the gun bore.

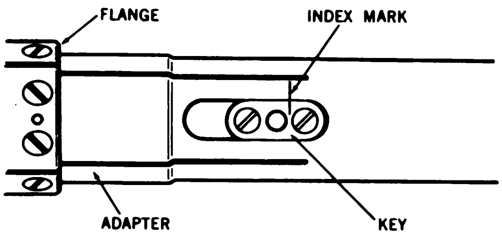
Withdraw the installation tool by turning it slightly in a counterclockwise direction disengaging the pins. The muzzle end assembly is now in place for the boresighting operation. The warning flag must always be attached to the assembly, and conspicuously displayed, to make certain the assembly is removed after completion of boresighting.

After boresighting, insert the installation tool and remove the muzzle end assembly by reversing the above procedure. Turn the installation tool counterclockwise.

For MK 12 guns, loosen the adapter extractor screw and place the adapter (fig. 10-7) on the breech end assembly. Then insert the extractor in the slot of the adapter and tighten the screw.

Insert the breech end assembly firmly into the gun breech, rotating the eyepiece end to a convenient viewing position to suit the particular gun installation as shown in figure 10-10.

To focus the breech end assembly, loosen the focusing tube lockring (fig. 10-6) and slide the eyepiece tube in or out to the desired position, and tighten the lockring. Orient the reticle



AO.566

Figure 10-4.—Index and key alinement indicating nonexpanded muzzle end assembly.

pattern and the target image by rotating the eyepiece end. The breech end assembly is now in position for boresighting operation.

Adjustments for correct boresighting can be made by referring to the appropriate Maintenance Instructions Manual for the specific aircraft being boresighted. After boresighting, remove the assembly by a slight rotation about the bore axis and a steady pull parallel to the axis.

Maintenance

The Boresighting Kit MK 3 Mod 0 will require no maintenance other than keeping the exterior lens surfaces clean. Components should not be oiled as some of the oil will seep into the tubes and onto inaccessible glass surfaces causing the image to be dimmed or blurred. Overhaul of the optical parts will be made only by officially designated major overhaul shops.

NOTE: After completing the boresighting operation, insure that the muzzle end and breech end assemblies are removed and returned to the carrying case.

For additional detailed information on the use and maintenance of the Boresighting Kit MK 3 Mod 0, refer to OP 2228 (current revision).

CAUTION: Before inserting either breech or muzzle assemblies, insure that the gun is clean and the bore is clear. Do not force components into or out of the breech or muzzle ends. Also, insure that the boresight installed warning flag is attached and showing when installing the muzzle end assembly.

CAMERA BORESIGHTING EQUIPMENT

Two basic types of gun camera boresights are in use at the present time. They are the film magazine type, which is inserted into the camera in place of the film magazine, and the camera type, which actually replaces the camera on the mount adapter. The latter type is used where a camera adapter plate is bolted to the mount providing for quick detachment and installation of the camera.

A gun camera boresight is a precision optical instrument and extreme care must be exercised in its assembly, disassembly, and use. It should be kept in its case when not in use. The optics in some boresights are made of optical plastic and demand special care in handling and cleaning. Use only authorized materials for cleaning of all optical equipment.

Although camera boresighting kits are issued with both straight and angle optical systems, it may be necessary in some camera installations to use special adapters which are furnished by the manufacturer of the specific model aircraft involved.

LAUNCHER BORESIGHTING EQUIPMENT

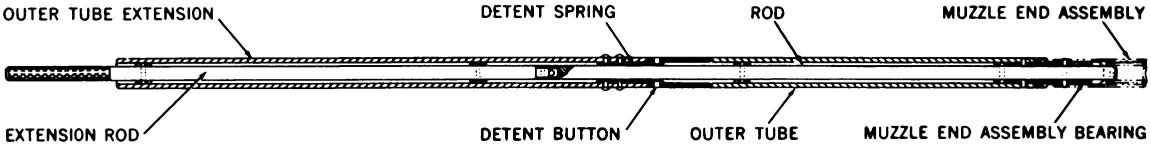
In some installations it is not possible to aline launchers, while on others the alinement of the pylons and launchers is required. On aircraft requiring alinement of launchers, a drawing or part numbers for the necessary equipment are given in the armament section of the Maintenance Instructions Manual.

AIRCRAFT ALINEMENT EQUIPMENT

Each aircraft manufacturer furnishes the necessary equipment for the proper alinement of the aircraft with the boresight target or screen. This equipment may be a telescope with mount post or in some instances, ring and peep sights. Regardless of the type of the equipment, the purpose is to properly aline the aircraft with the boresight target prior to boresighting.

MISCELLANEOUS EQUIPMENT

In addition to the equipment already mentioned, many other items are required to properly boresight an aircraft. A source of power (a.c. and d.c.) and high pressure air, jacks,



AO.567

Figure 10-5.—Installation tool—Section view.

jackpads, level, tiedowns, boresight target screen, and a kit of standard handtools are necessary to complete the routine boresighting of an aircraft.

BORESIGHT SCREENS

Boresight screens or targets for operational aircraft may be considerably more complex than for the aircraft of a few years ago. In addition to points for guns, sights, cameras, and the datum line, points for radar antennas, rocket launchers, and missile launchers, may be required on the screen or target. The Maintenance Instructions Manual (Armament Section) for each type of aircraft gives a pattern and usually an alternate pattern for the boresight target board required for that type of aircraft.

There are many basic factors to be considered prior to the actual construction of a boresight screen for a particular aircraft. These factors are as follows:

1. Type of armament employed.
2. Type of sighting device used.
3. Range of the guns installed.
4. Range of the rockets and other armament installed.
5. Whether the guns are to be boresighted to converge or to be parallel.
6. At what range or ranges they are to converge.
7. The type and construction of the screen itself, as well as the materials from which it is to be constructed.
8. Gravity drop for range to which guns are boresighted.

The dimensions of a boresight screen should be such that all boresight points of the armament will fall well within the sides, as well as have sufficient space in which to plot the vertical and horizontal reference lines. Therefore, the overall dimensions of the screen must be based on the distance the screen is to be used from the aircraft and the locations of the boresight points of the guns and other armament to be boresighted.

The boresight target or screen may be constructed of any suitable material. Where the guns cannot be fired-in, the targets are usually of rigid material, such as plywood or hard board. They may either have legs or be attached to a workstand or some other structure. These targets or screens may be reused for aircraft of the same type and model.

Where fire-in is possible, a screen made of banner target material or heavy paper material may be used. The screen may be attached to a light wood frame, much the same as target backing material is secured to frames on a rifle range. In the case of the target banner material, no frame is necessary. This nonrigid type screen may be used to boresight, and then fire-in the aircraft in certain situations. When used for boresighting and firing-in, the screen is usually mounted in the butts between two posts, which have rigging and tackle for raising, leveling, and securing the screen between them. (See fig. 10-11.) Provisions must be made for securing boresight screens of all types to insure that they remain in the same position until boresighting is completed.

Construction of boresight-fire-in screens is simple. The basic problem is one of making a stencil or template of heavy paper or any other suitable material. First the target pattern, taken from the Maintenance Instructions Manual (or computed if the boresight pattern is to be nonstandard), is laid out on the chosen stencil material. After the layout is completed, the points for the guns, launchers, sight, cameras, datum point, and reference lines are cut out of the stencil, usually in the shape of crosses or

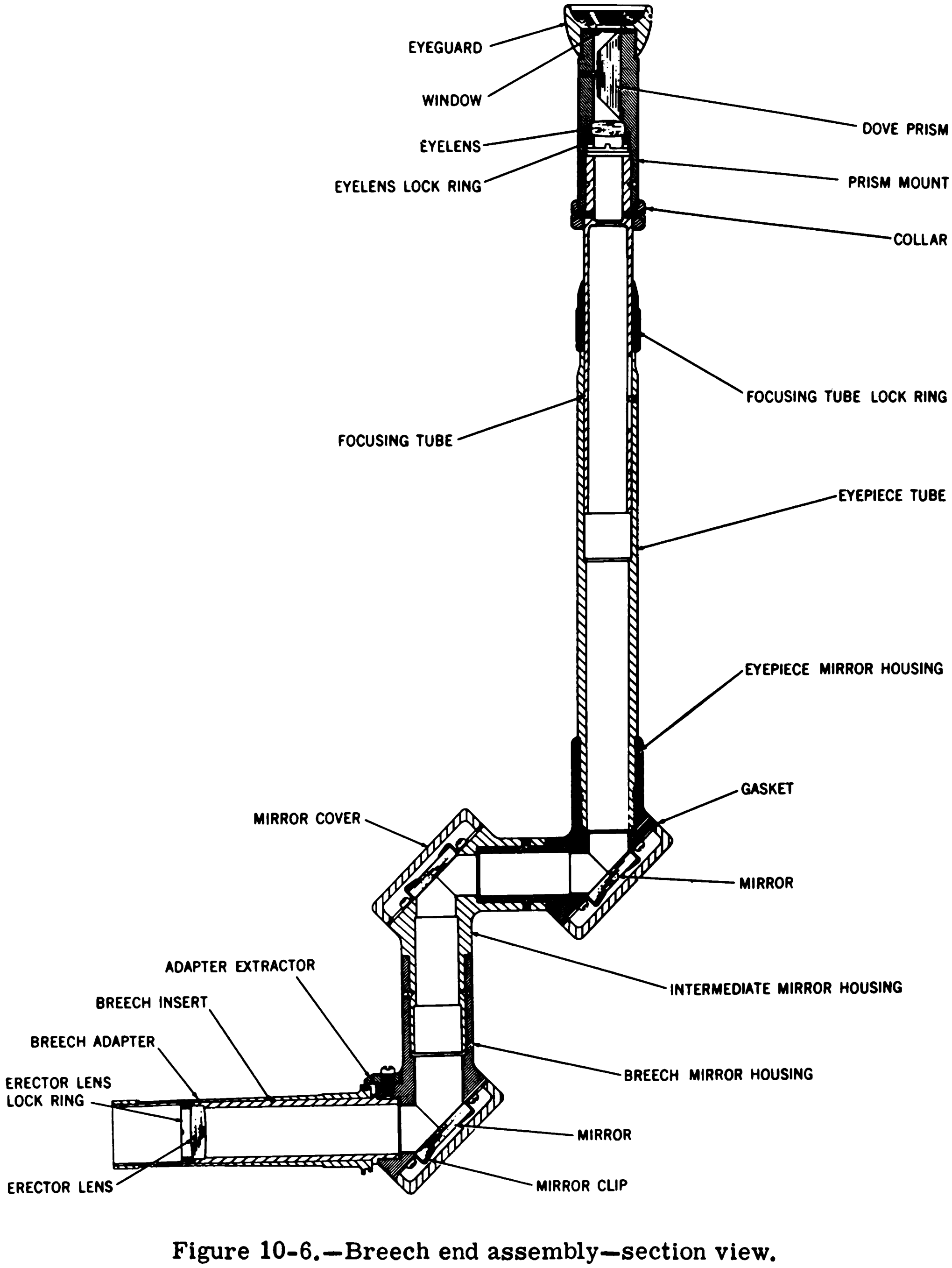


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Figure 10-6.—Breech end assembly—section view.

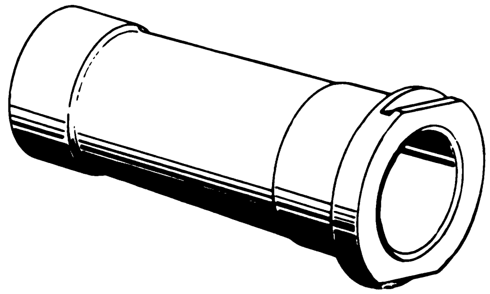

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Figure 10-7.—Breech adapter used in boresighting the MK 12 aircraft gun.

circles; the reference lines are cut in the shape of dash lines leaving sufficient material to insure that the stencil will not become distorted. The stencil may then be laid over the target screen material and a spray gun or Aerosol can containing any suitable paint may be used to reproduce the pattern on the boresight screen material. With care, the stencil may be used to lay out many boresight screens. It can be cleaned and put away for future use.

If it is desired to use a nonstandard pattern (i.e., one other than the pattern given in the Maintenance Instructions Manual), it is necessary to compute the proper position for each point on the target screen.

In computing for the point positions on a nonstandard screen, only the horizontal convergence of the line of fire may be desired, since the fire control system in most present aircraft solves the problem of time of flight and ballistic coefficients for the particular armament in use. However, it may be desired to converge the line of sight and the lines of fire in some instances; consequently, both horizontal and vertical problems are discussed.

In the preparation of a nonstandard boresight screen, first consult the Maintenance Instructions Manual for the particular type and model of aircraft involved. There may be found the tabulation of the vertical and horizontal offsets. These offsets denote in detail exactly how much offset distance there will be between the armament items and the gunsight in both horizontal and vertical directions. This information is needed in calculating the dimensions and detail plotting of the various boresight points on the target screen. Minor errors in making these calculations will be less damaging to the accuracy of the gunfire if the boresighting is performed for long ranges, and conversely, at short ranges any errors are greatly magnified; even to the extent of possibly causing complete misses in gunnery exercises or combat. Therefore, it is necessary to perform boresighting at the longest ranges compatible with existing local conditions.

An example requiring a nonstandard boresight screen is one in which the lines of fire and the line of sight converge at 1,000 yards, and the boresight screen must be constructed for use at 300 yards. (See figs. 10-12 and 10-13.)

The problem is to locate the points on the boresight screen where the lines of fire and the line of sight should intersect the boresight screen on their way to converge at 1,000 yards. We know the horizontal and vertical offsets (taken from the Maintenance Instructions Manual), the range, and the distance the screen is to be in front of the aircraft. We need only to solve for the corresponding horizontal and vertical offsets to be plotted on the screen. One method of accomplishing this is to make use of similar triangles and solving for unknowns by proportions. First solve for the corresponding horizontal offsets. The distance AB in figure 10-12 was found to be 21.3 inches, the distance BD has been given as 10,800 inches (300 yards), and the distance BR is 36,000 inches (1,000 yards). By placing these known distances in proportion we have:

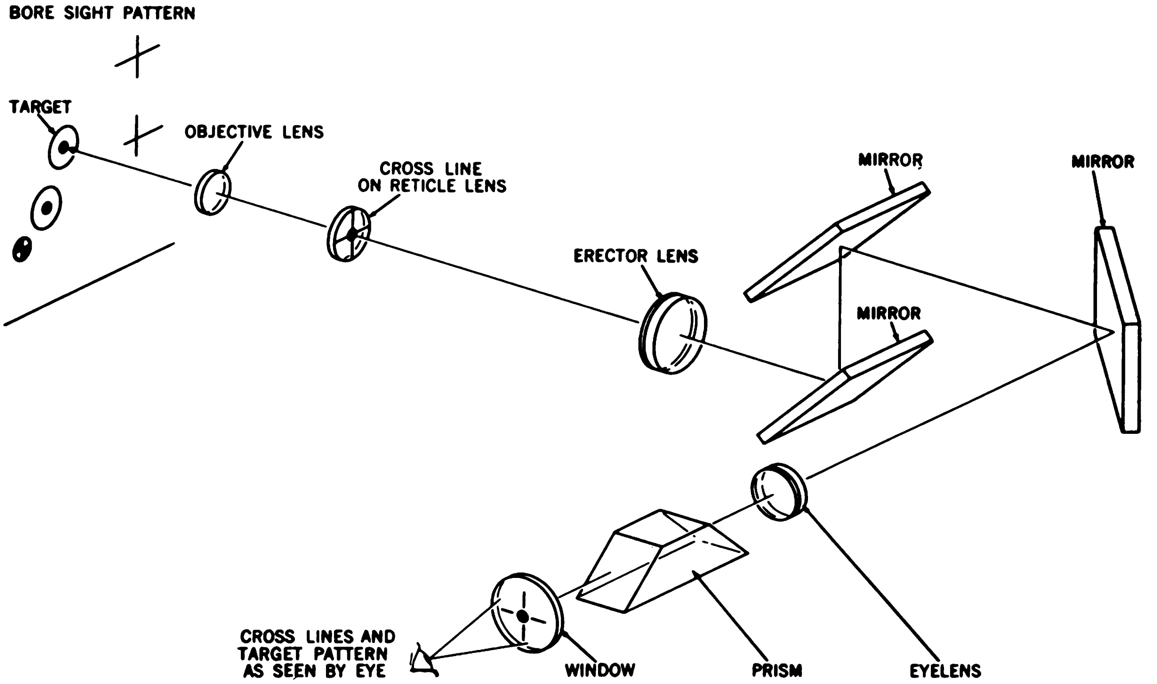
$$\frac{CD}{AB} = \frac{DR}{BR}$$

$$\frac{CD}{21.3} = \frac{25{,}200}{36{,}000}$$

$$CD = \frac{25{,}000}{36{,}000} \times 21.3$$

$$CD = 0.7 \times 21.3 = 14.97 \text{ inches horizontal offset.}$$

Thus the horizontal offset for the port outboard gun (at A) is 14.97 inches from the centerline of the aircraft. In this particular boresighting problem, the line of sight and the lines of fire are to converge at 1,000 yards. The vertical offset of the gunsight is greater than the vertical offset of the gun. Since this is true, the gun must be elevated if its line of fire is to converge with the line of sight at 1,000 yards. It then follows



AO.570

Figure 10-8.—Complete optical system.

that the corresponding vertical offset of the gun is greater than the actual vertical offset. Thus, the line of sight rather than the boresight datum line is used as the common base of the similar triangles. (See fig. 10-13.) The total computed vertical offset of the sight from the port outboard gun, the distance AB, is 37.4 inches. Again, substituting in the above formula, we have:

$$\frac{CD}{37.4} = \frac{25{,}200}{36{,}000}$$

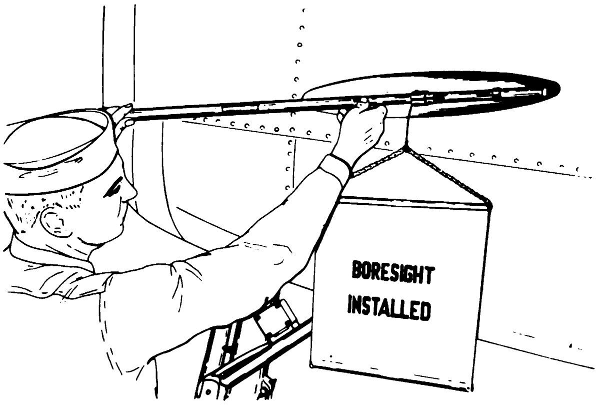
$$CD = \frac{25{,}200}{36{,}000} \times 37.4$$

$$CD = 26.18 \text{ inches vertical offset.}$$

The above solutions establish the linear distances from the vertical and horizontal reference lines drawn on the target screen at which the port upper gun boresight point is to be plotted on the screen. The armament on the portside has to be calculated in the same manner as above. The gun at point A' is calculated next, and then the gun camera.

Since the lines AB in both figures 10-12 and 10-13 are in the plane of symmetry in both a horizontal and vertical aspect with regard to the guns and gunsight, all guns (and other armament) on the opposite (starboard) side may be plotted by employing the corresponding vertical and horizontal offsets established previously for the armament on the portside. In the event that a boresight screen has to be prepared for parallel boresighting instead of convergence firing, as illustrated in the above example, the Maintenance Instructions Manual for the aircraft concerned will provide all the necessary information. These offsets may then be plotted directly on the boresight screen using the reference lines (vertical and horizontal) as the origin of all measurements. However, this procedure would not take into consideration the vertical offset between the gun bore line and the sight line. In other words, no allowance for parallax has been made.

In some aircraft all items of armament are boresighted parallel to each other and to the boresight datum line. In these instances it is not necessary to make an allowance for parallax, as the guns and the gunsight are close enough to one another to obviate the necessity of such an allowance. In some instances the installation is such that the armament items are boresighted parallel, but the sight is offset from the guns to such an extent that an allowance for parallax has to be made. In other words, the guns have to be harmonized with the sight in the plane of vertical offset so that the gunsight line and the boresight line converge at some point within the trajectory. In this case the corresponding horizontal offsets will be the same as the actual horizontal offsets. However, the corresponding vertical offsets will be different and will have to be calculated as shown in figure 10-13.



AO.571
Figure 10-9.–Installation of the muzzle end assembly and warning flag.

In laying out the boresight screen, lay off a horizontal line running the full width of the screen and near the bottom. A vertical line is then laid off in the center of the screen which is exactly perpendicular to the horizontal line. These are the reference lines for the screen from which all boresight points and other data are plotted. The intersection of these two lines normally form the boresight datum point on the screen.

The corresponding vertical and horizontal offsets previously calculated may now be laid off by careful measurements on the screen or stencil. When laying out the points, each point should be identified to prevent boresighting errors which may occur by aligning a gun or guns with the wrong boresight point. The points may be identified by any suitable method, such as using different colored paint for the different points, or numbering, or both.

SHORT RANGE BORESIGHTING

Short range boresighting is used where space is at a premium such as on an aircraft carrier. In past years short range boresighting was not considered the best method and was only used when necessary.

Modern aircraft can now be boresighted, with accuracy, utilizing the short range boresight equipment provided by the aircraft manufacturer. Figure 10-14 shows a typical short range boresighting kit installed on an aircraft. The equipment is installed on the structure of the aircraft which eliminates the need of jacking or leveling. When the equipment is installed correctly on to the aircraft, the AO can accurately boresight the guns and sighting device. The

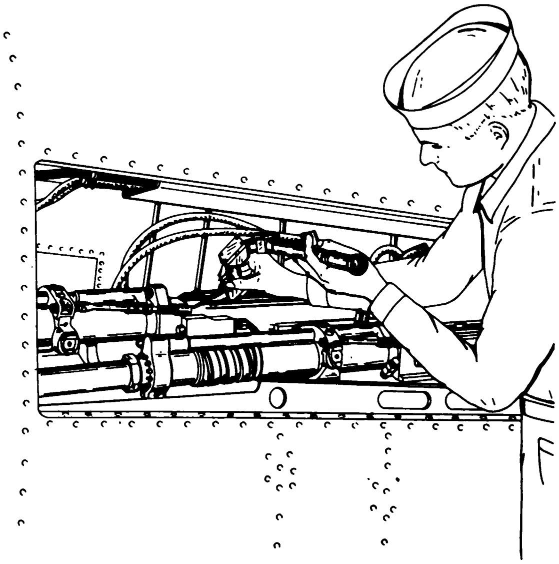


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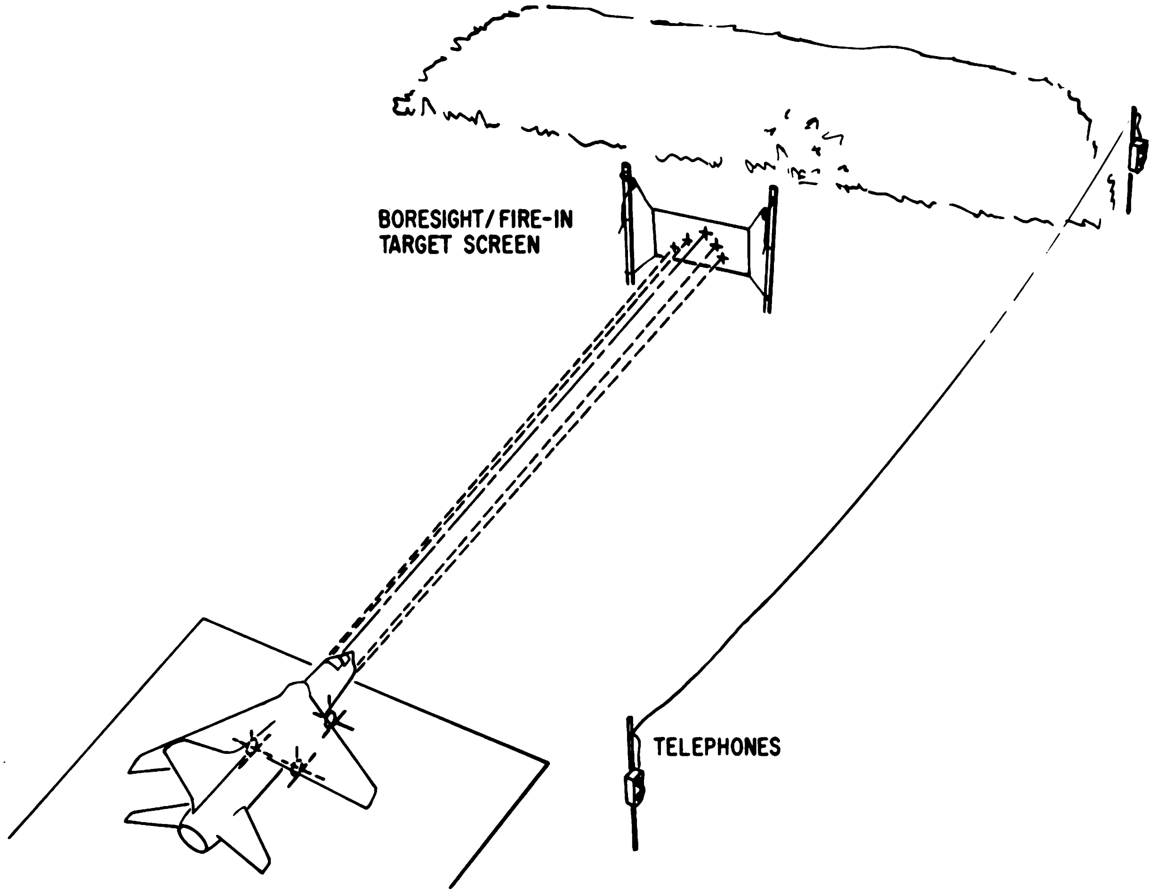
Figure 10-10.–Installation of breech end assembly.



AO.573

Figure 10-11.–Boresighting and fire-in range.

AQ and AT ratings also utilize this equipment in alinement of their computers and navigation equipment.

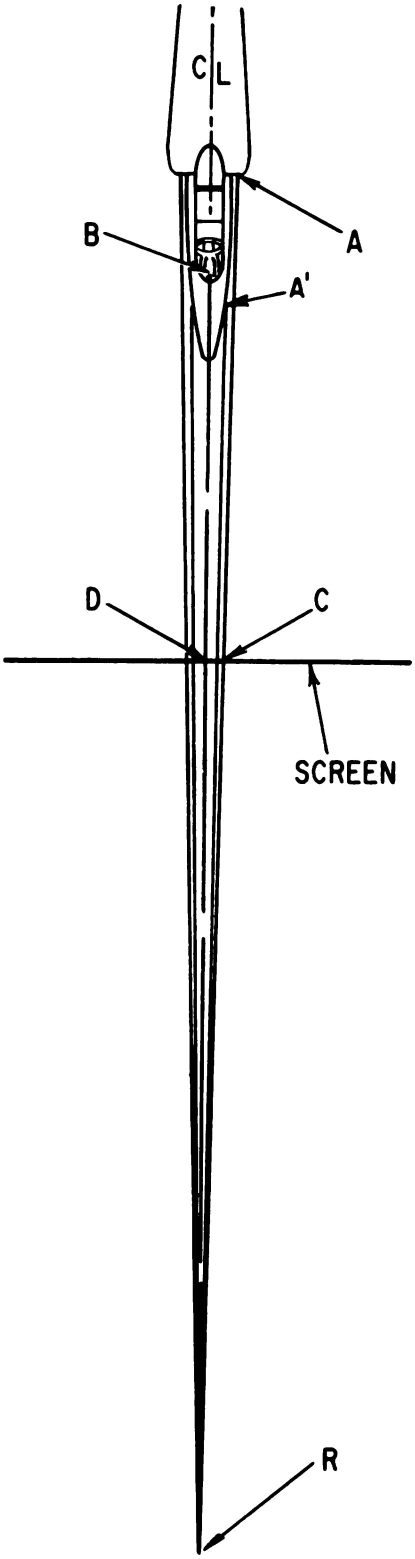
The equipment is considered to be a precision instrument and must be calibrated by a Naval Air Rework Facility (NARF). Care must be exercised to avoid dropping or bumping the equipment to maintain its calibrations.

Each type of aircraft is provided with its own short range boresighting equipment; procedures for installation and alinement of the aircraft equipment are contained in the Maintenance Instruction Manual for that particular type of aircraft.

BORESIGHTING PROCEDURES

GENERAL CONSIDERATIONS

An aircraft operating activity will normally have periods in which there will be an opportunity to overhaul and boresight the armament of its aircraft. However, the leading ordnanceman, working closely with the avionics officer of the activity, will have to anticipate such periods and schedule the necessary work. (Past experience has shown that there is little actual time in which the aircraft is available for this important work.) All possible arrangements should be made in advance of actual boresighting, so that the job



AO.574
Figure 10-12.–Boresight screen—plan view.

may be carried out in the minimum length of time and with the least confusion. Different boresighting equipment and gear may be needed for each type of aircraft. This fact should be taken into consideration when accumulating the necessary equipment. Since rockets and other types of missiles are widely used on modern combat aircraft, provisions must be made for proper boresighting of the launchers when necessary.

Whenever possible guns should be fired-in after they are boresighted. This requires that the boresighting be carried out at the butts, which is the most desired arrangement, or after boresighting, the aircraft must be moved to the butts, alined, and securely tied down. Where boresighting can be carried out in the butts, the use of a boresight screen made of target banner material may be used to boresight and then test fire the guns. By using a different color of bullet tipping paint for each gun, an accurate and permanent record of the pattern fired by each individual gun is established. The only disadvantage of this method is that a boresight fire-in screen may be used for only one aircraft. However, the simplicity of construction of the screens (given previously in this chapter) makes it one of the most desirable methods of boresighting.

Unless the aircraft has been boresighted at the butts, fire-in requires alinement of the aircraft, so that the guns will fire into the butts. Only practice ammunition may be used for test firing at the butts. This excludes all ammunition of pyrotechnic and explosive classification.

All safety precautions must be observed at all times with particular emphasis on the handling of ammunition and the actual firing of the guns.

There will be a variety of circumstances, other than the above, which demand additional or different types of boresighting equipment. It will be the duty of those in charge of the ordnance phases of work in the unit to anticipate the needs of the unit, and see to it that all is in readiness for the relatively short periods of time in which boresighting and general ordnance maintenance work may be accomplished.

Due to the many problems involved in boresighting present types of aircraft, shipboard boresighting should only be performed on aircraft that have close quarters kits (short range equipment) provided, or in an emergency. Any emergency boresighting carried out aboard ship will have its own specific problems, which must be worked out as the situation dictates.

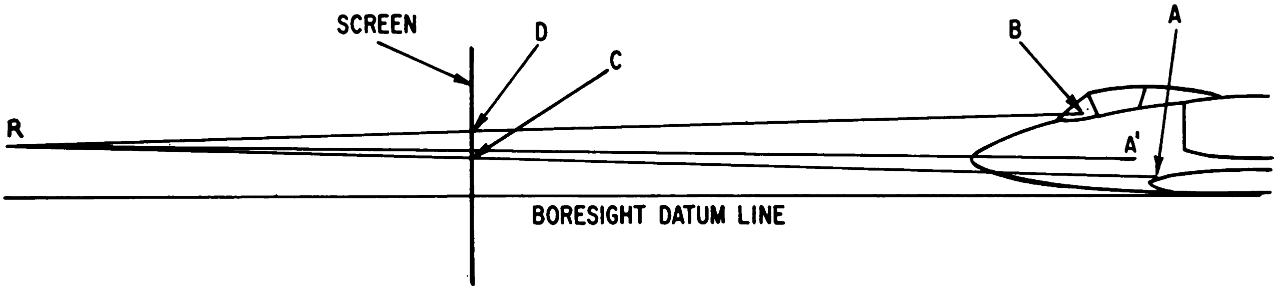


Figure 10-13.–Boresight screen—side view.

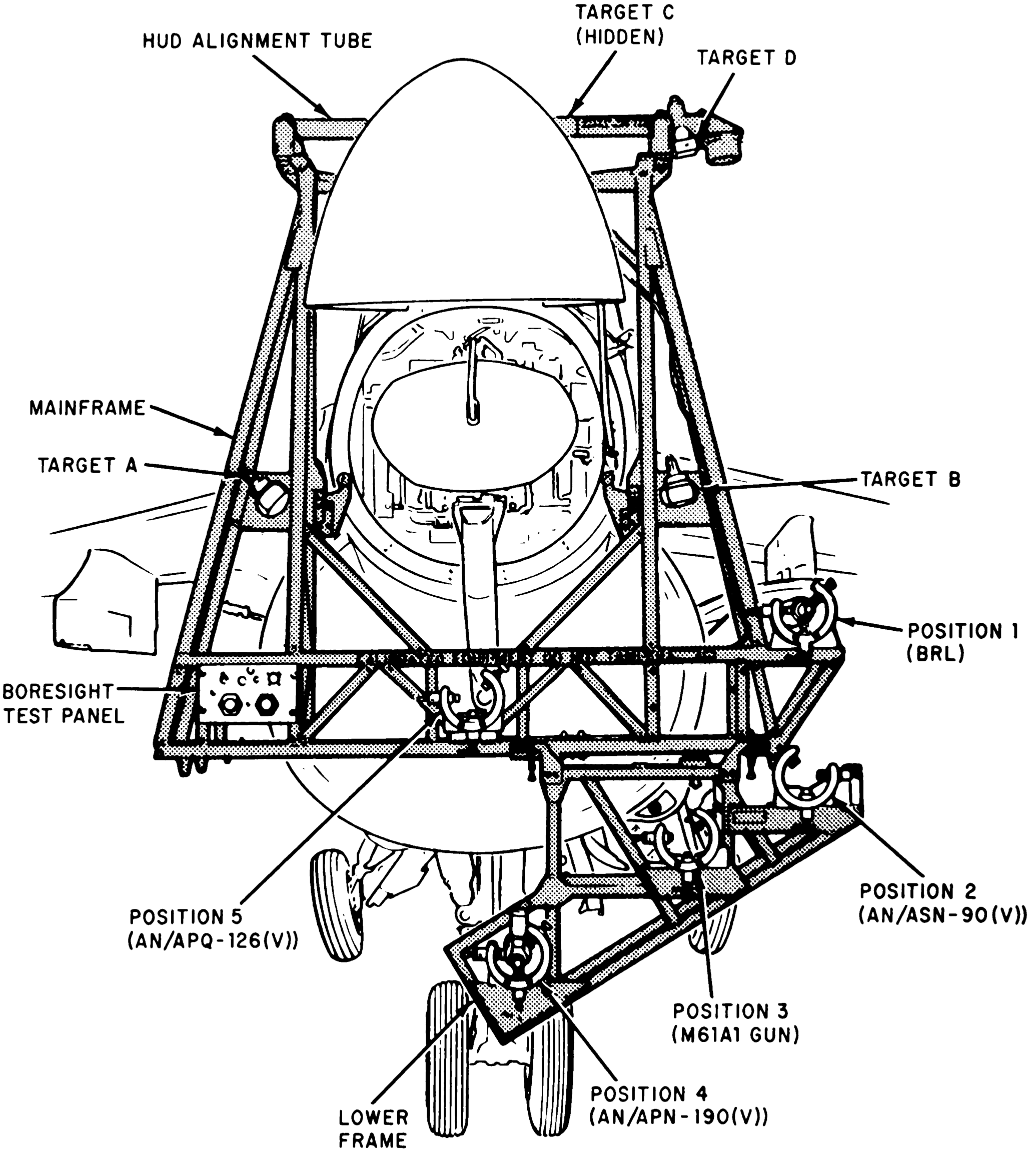
BORESIGHTING CREWS

As a general rule, there will not be a great deal of time available to the ordnance branch in an operating activity in which to boresight the armament of their aircraft. Many phases of daily operation necessarily take precedence over boresighting, and as a result, boresighting is sometimes relegated to a foul weather or spare time project. The leading ordnanceman must realize this and should confer with other involved branches and his subordinates in laying out a workable and instantly available overall plan by which the aircraft may be kept in boresight. His plan should include a setup for boresighting single aircraft as they become available during or after routine checks, and should be flexible enough to handle an emergency situation in which all the aircraft may have to be boresighted at once, should it become necessary to switch boresight patterns or for other reasons. The basic unit in any planning of this type will be the boresighting crew, or crews.

The leading ordnanceman should divide his men into crews, the composition and number in each crew being dependent upon the type of aircraft, the number of aircraft, the complexity of the boresighting job at hand, the number of ordnance and other personnel available to him, and other existing factors. He may divide the men into two groups, with a first class ordnanceman in charge of each group. Each of these two groups, or crews, may be further divided into crews with a third class petty officer in charge. No matter how divided, the leading ordnanceman should assure himself that each crew knows what to do under each situation, and where to obtain the necessary equipment with which to do that particular job. Only with such an organization, or other equally careful planning, will the leading ordnanceman have confidence that his men will be able to meet the demands of this work.

One of the major items to be considered and planned for when boresighting current and future aircraft is the division of responsibilities between the Aviation Ordnanceman and the Aviation Fire Control Technician, and at times, the Aviation Electricians, Aviation Structural Mechanics, and Aviation Electronics Technicians. The duties of each rating are well defined in the Manual of Qualifications for Advancement, NavPers 18068 (Revised). However, there will be times when their duties may overlap one another, and if provisions are not made for such contingencies, confusion may result. Most overlapping that occurs may be resolved on the squadron level after proper considerations have been given by those concerned with planning and organization. Each subsequent change to the above manual delineates these responsibilities more closely so that there should be less and less overlapping.

The boresighting of the aircraft may require the use of a large amount of heavy equipment, such as jacks, hoist, external power, and other items. These items will most likely have to be borrowed from other branches of the activity or the supporting activity (AIMD or IMA). Here again, the leading ordnanceman will have to



AO.576

Figure 10-14.–Typical short range boresighting equipment.

plan the boresighting to make efficient use of the equipment when it is available to the ordnance crews. It will also be the responsibility of the leading ordnanceman to insure that each individual is checked out in the operation of the gear that he will be using. In the case of power-operated equipment, insure that the operators are properly licensed to operate the equipment being used.

In the estimation of some, boresighting is just one of the necessary evils associated with operations. However, the pilot who realizes that his armament has had proper maintenance will perform his duties in combat with confidence. Regardless of the difficulties involved, alining all aircraft into perfect boresight and maintaining them in this condition, is one of the most important functions of the AO.

PLANNING THE OPERATION

A general plan for boresighting the aircraft of an activity may be as follows:

1. Plan the operation.
2. Set into motion the boresighting crews previously organized.
3. Prepare the screens, if not already prepared.
4. Schedule the boresighting.
5. Check the equipment to be used for availability and condition. Do not overlook the condition of the safety features incorporated.
6. Move the gear to the boresighting area.
7. Move the aircraft to the boresighting area.
8. Carefully position the aircraft the prescribed distance from the target screen, and elevate to boresighting position.
9. Check the aircraft's guns to see that they are clear (not loaded). Remove all ordnance from the aircraft (bombs, rockets, missiles, etc.).
10. Boresight the gunsight (this job is sometimes done by Fire Control Technicians).
11. Boresight the gun camera(s).
12. Boresight the guns.
13. Boresight all other armament (pods and launchers, etc.).
14. Have Fire Control Technicians boresight the fire control equipment (antennas).
15. Recheck all boresighting and alinement of the aircraft with the screen.
16. Safety wire or otherwise secure the armament.
17. Observe all range safety precautions. Be sure that all boresighting equipment and tools have been removed from the aircraft and accounted for. Insure that the aircraft is removed from the jacks prior to firing, so that it will not vibrate off during firing. Only authorized personnel should fire the guns.
18. Fire-in wherever possible.

As a first class or chief petty officer, you will be called on and required to teach and supervise the work of the rated men and strikers in all the phases of ordnance work of your unit. In addition, you may be called on to demonstrate certain phases of your work to the pilots of the activity. It is therefore expedient that your procedures and schedules be worked out to the best possible point in order that your time may be utilized most advantageously. As you well know, your work is quite apt to come in spurts. Be prepared for this by planning ahead.

ALINING THE AIRCRAFT WITH THE BORESIGHT SCREEN

In order to place the aircraft into proper position and attitude for boresighting, it is normally necessary to aline the armament boresight datum line with its proper point on the boresight screen (by sighting with the datum sight provided with the aircraft). These sights are constructed similar to the sights on small arms; that is, they are open sights, peepsights, sights with crosshairs, or telescope sights. There are numerous variations, most are fixed, but some have adjustable features in order that the datum line may be changed to boresight various items of armament. The sights are normally fitted into the structure of the aircraft at locations best suited to the armament configuration concerned.

Regardless of where the sights are erected when in use, they are employed for one purpose—that of alining the boresight datum line with the boresight target in order to boresight the armament. Reference lines which are normal (90°) to one another are laid out on the target screen, and the sight lines of the datum sights are alined with the reference lines in both azimuth and elevation by shifting the aircraft or the screen. After these alinements have been made and the aircraft and the screen are secured in their proper positions, the aircraft is ready for boresighting.

Most of the datum sights are of the fixed type. That is, when installed there is no furthur possible adjustment. However, there are some datum sights which have adjustable features incorporated. In this type sight, the rear bracket may contain crosshairs which are vertically adjustable having scribe lines to indicate the various positions of the sight. Another type of adjustable sight is a telescope sight. It is adjusted vertically by positioning the front end of the telescope in one of three mount holes provided in the front bracket. The adjustable feature is incorporated for the purpose of altering the angular relation between the aircraft and screen. This allows for various degrees of depression of the armament items to different configuration requirements. Also, in some instances the adjustment may be used in the alinement procedure to insure that the horizontal reference line is parallel laterally to the lateral axis of the aircraft.

This attitude can be established between the aircraft and screen by sighting the vertical reference line with the sight in one position, and then moving the sight to its extreme opposite vetical position. If the sight in both positions falls within the acceptable tolerances on the vertical reference line on the screen then, the horizontal reference line is laterally parallel with the lateral axis of the aircraft, and the aircraft will not require leveling.

There are a great number of methods by which the aircraft may be set up for boresighting. The best method for each type aircraft is outlined in detail by the manufacturer. One aircraft may be brought into a longitudinally level condition by elevating the tail, and jacking up the wings for leveling the lateral axis. Another may be leveled by easing the nosewheel down a specially prepared ramp and leveling the wings by adjusting pneumatic pressures in the oleo struts and tires. Still another may be leveled by the expedient of equalizing the pneumatic pressures in the oleo struts and tires for lateral leveling, and either inflating or deflating the nosewheel oleo strut for longitudinal leveling.

Leveling lugs are provided in some aircraft. A spirit level or clinometer is placed on these lugs both in a fore-and-aft position for the longitudinal check, and in an athwartships position for lateral check during the leveling process. (See fig. 10-15.) Other aircraft make use of a plumb bob method for leveling. A plumb bob is suspended from a special hanger within the aircraft. A graduated scale, calibrated in degrees, is located on a structural member over which the bob may closely swing. When the bob settles into the center of the chart graduations, the aircraft has been leveled. There are other systems of arranging the plumb bob and scale, but they all perform the same function which is to indicate the exact position on the scale at which the aircraft has attained a level condition.

There are numerous methods of alining the aircraft with the boresight screen, the fundamental purpose of any and all these methods is to position the aircraft so that its boresight datum line is parallel to the level ground or to a plane extended to which the target is at right angles. The boresight screens have to be perpendicularly erect, parallel laterally to the lateral axis of the aircraft, and at the exact distance in front of the aircraft for which the screen or target is designed.

BORESIGHTING THE SIGHT

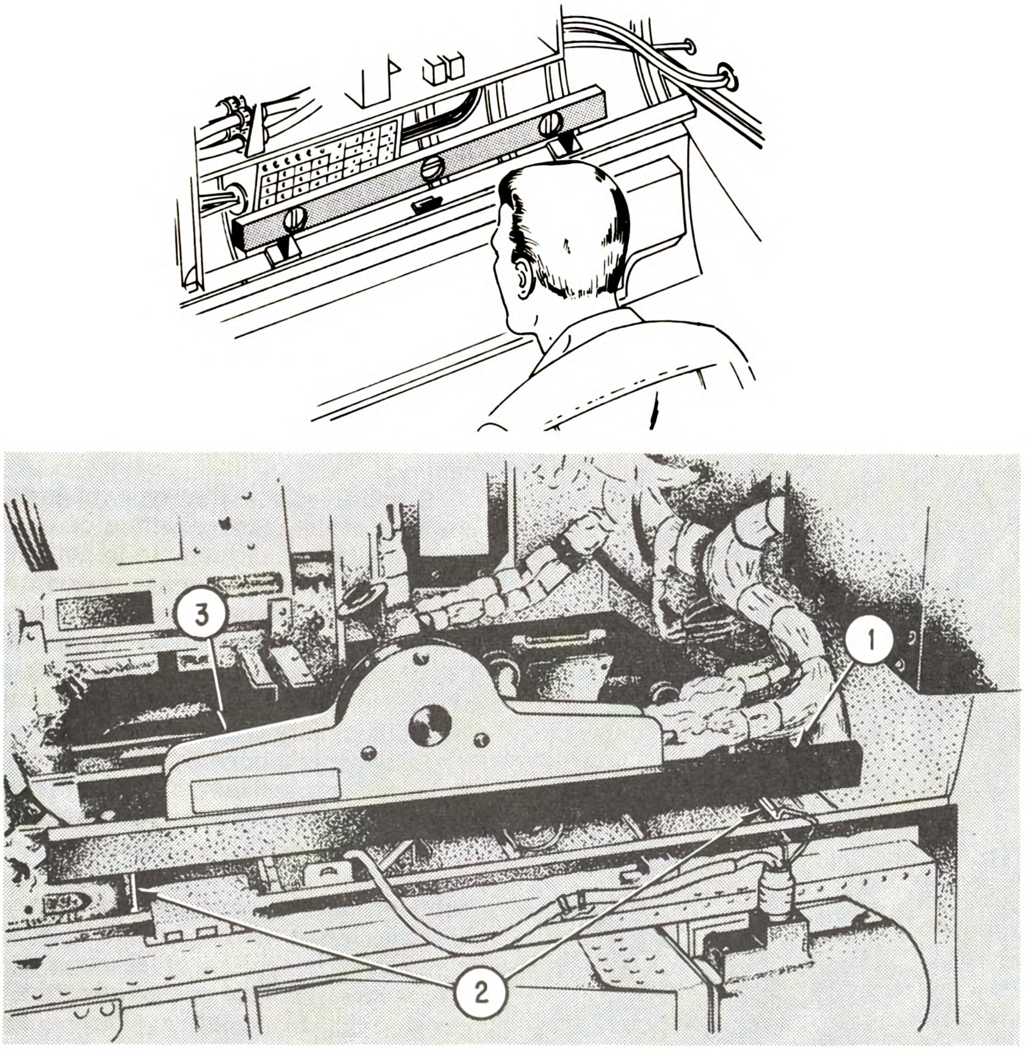
After the aircraft has been leveled and the reference lines (horizontal and vertical) alined with the datum sight of the aircraft, the next step is to aline or boresight the gunsight.

Practically every gunsight has its own set of instructions for boresighting. This is due to the diversity of the mounting devices and to the mechanical makeup of the sights themselves. Since there are many different types of sighting devices, only the boresighting of one of the currently used sights, the Mk 11 and Mods (fig. 10-16), is discussed.

An accurate job of boresighting cannot be performed if the sight itself is not accurately and solidly mounted. The boresighting procedure must be repeated if it is later found that the mounts are defective or loose. Check all mounts for defects, broken elements, and security before commencing to boresight.

Illuminate the fixed reticle of the gunsight to a comfortable brilliance, and operate the fixed reticle image selector knob to unmask the fixed reticle image. Observe the vertical alinement of the ladder markings of the fixed image as compared with the vertical reference line of the target screen. If they do not coincide, tilt the sight in the proper direction by turning the tilt boresight control until they do coincide. The boresight cables are detented to lock every 90 degrees of rotation. Each cable is turned by inserting a screwdriver into one of the slots and pressing in until the detent is free. The cable has to be turned in increments of 90 degrees because it may not be allowed to remain between the detents.

Next, note the position of the center of the fixed reticle image with respect to the boresight point on the screen. If not coincident, the sight should be alined by means of the elevation boresight control and the azimuth adjustment screws. Turn the elevation boresight control to center the fixed reticle image-vertically with the boresight point, then center the fixed reticle image laterally by loosening one azimuth adjustment screw while tightening the opposite screw. Recheck the orientation of the ladder steps of the reticle image (fixed) with the vertical reference line of the boresight target screen and make any minor adjustments found to be necessary. The gunsight is now boresighted.



1. Straight edge.
2. Airplane leveling lugs.
3. Clinometer.

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Figure 10-15.—Leveling lug provisions.

The boresighting of computing sights, radar antennas, gyro mounts, yaw and angle of attack units is the responsibility of the AQ ratings.

BORESIGHTING THE GUN CAMERA

The mounting assemblies and the methods of mounting the aircraft gun camera vary. The 16-mm motion picture camera has been mounted in practically every forward part of an aircraft to record pictorially the results of the aircraft's practice and combat missions. (Its ability to be placed at strategic locations and to record the results of tests on the aircraft, its armament and the physiological aspects of the human body undergoing accelerations of gravity and anoxia (oxygen deficiency) have made the camera a vital tool in many types of research.)

There are a great many types of mounting systems for the gun camera when used for its original purpose of recording aircraft gunfire. In one installation the camera may be mounted in the aircraft at a point not too remote from the guns. In another installation, it is mounted

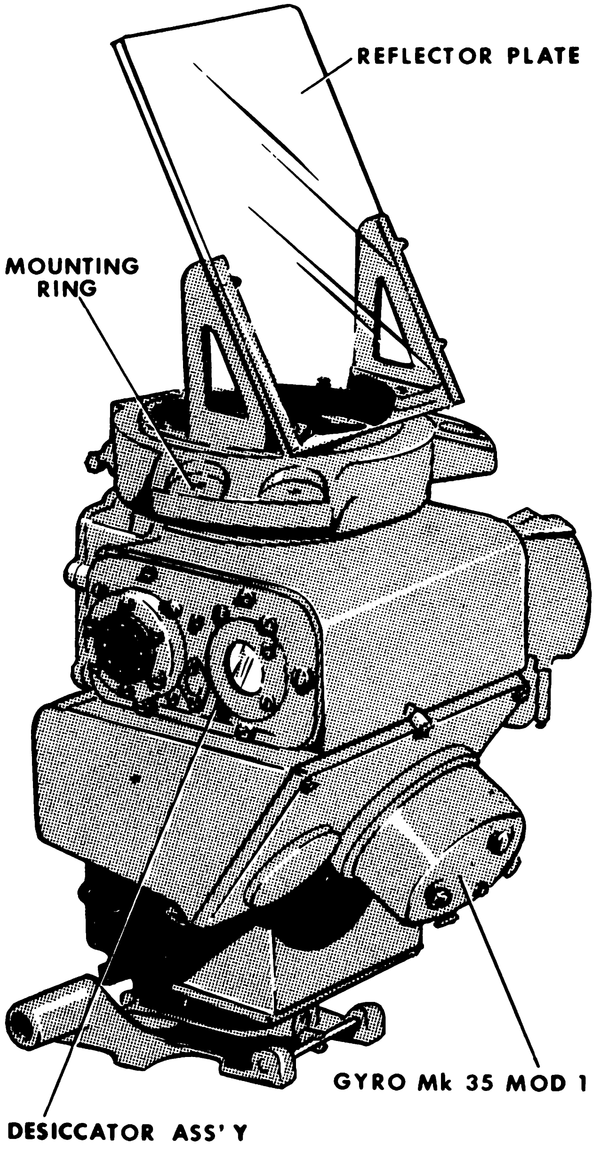

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Figure 10-16.—Mk 11 and Mods gunsight.

on the sight head and functions as a gunsight recording camera, and serves to record the sight image and the target. When mounted in this position the camera is referred to as a gunsight recording camera. Mounted in other positions it is usually referred to as a gun strike camera.

As for the gun camera mounts, in one installation the mount will be an integral part of the aircraft, in another the mount will be attached to the camera and the entire assembly bolted to the aircraft rigidly or attached by a hinge system to the aircraft for easy servicing by swinging outward.

A third type has a plate which is secured to the mount, and the camera attaches to this plate with a quick detachable mechanism. In this arrangement the power for operation of the camera is supplied through a socket on the plate, which mates with the contacts on the camera.

Regardless of the type of mount and the position of the camera within or on the aircraft, the mounts are adjustable in both elevation and azimuth. However, since the mounts and methods of attachment vary to such an extent, it is not practical to described them in this chapter. Details of installing and adjusting gun camera are found in the Maintenance Instructions Manual for the aircraft concerned.

Gun camera boresights are precision optical instruments, and extreme care must be exercised in assembling and handling these instruments. They should be kept in their cases when not in use. Avoid touching any of the optical surfaces with the fingers, and if the case should become dusty inside, clean it with a vacuum cleaner. The optics of some of these instruments are made of optical plastics and demand great care in handling. There are only two cleaners for the optics which are authorized. One is pure castile soap in clean water, and the other is a one percent Aerosol (dioctyl sodium sulfosuccinate) solution in clean water. Cleaners or other liquids such as alcohol, acetone, etc. are prohibited.

BORESIGHTING THE GUNS

A great deal of thought, money, and effort has gone into the production and installation of the armament that equips our current operational aircraft. The armament is installed for one major purpose—that of destroying any enemy with whom we may be forced into open combat.

Armament that is subject to frequent malfunction due to poor design, faulty maintenance, or improper boresighting is of little value in combat. While the ordnanceman cannot always correct discrepancies in design, it is his duty to insure that the armament is in perfect alinement and working order.

The first step in boresighting is the alinement of the aircraft with the boresight screen. This is accomplished by following one of the previously mentioned procedures. Remember that the screen and the aircraft must be at a specified distance apart; must be parallel in both the vertical and lateral axes within specific tolerances (given in the Armament Section of the Maintenance Instructions Manual) and must be steady when the boresighting is being performed.

Typical tolerance requirements for boresighting an aircraft using a 1,000-inch screen are as follows:

1. Distance from the center of the front boresight telescope mount post to boresight screen—977.9 inches ± 1.0 inch.

2. Lateral and vertical axes of the aircraft and boresight screen must be parallel within ±5.0 degrees.

During the process of boresighting, it is possible to displace either or both the aircraft and/or screen by climbing over the aircraft or bumping the screen to such an extent that the otherwise carefully adjusted armament will not be correctly boresighted upon completion. It is therefore wise to check the alinement of the datum point sight periodically during the process with the datum line boresight point on the screen. The ordnanceman in charge of the boresighting crew should make such a check after the boresighting is completed, and before either the aircraft or screen is moved from their boresighting positions. At this time, if the datum point sight is still in alinement and the boresighting has been accurately performed, it is safe to assume that the armament is in proper boresight.

There are many different designs of mounts for aircraft guns. Essentially these mounts serve but one major purpose, that of forming a rigid adjustable base within the aircraft upon which the guns may be installed. The mounts have to be solidly constructed and anchored in order to absorb, without permenent distortion, the shock generated by the guns while firing. They must also have incorporated a means by which the guns are adjusted in both azimuth and elevation so that they may be properly boresighted. Normally, the gun mounts are so designed that the guns can be removed from the mounts by releasing a locking device incorporated for rapid replacement of the guns or ease of maintenance work. The adjustments for both azimuth and elevation (depression) may be found on either the front or rear mount, depending on the installation.

Some guns use a three-point mounting system, the third mount being near the muzzle. It may be referred to as a muzzle stabilizer, or muzzle mount. The mount also acts as a gas seal to prevent the gun's gases from entering the gun bay around the gun barrel on some aircraft. The third mount should be loosened to permit proper alinement of the guns during boresighting. (Some aircraft have only the floating type gas seals instead of a third mount, while the A-7E utilizes a gas purge system to remove gun gases.)

After boresighting a gun it will usually be necessary to check for sufficient projectile clearance between the path of the projectile and the aircraft structure. Some aircraft manufacturers furnish tools for this purpose, while others include in the Maintenance Instructions Manual specifications for their local manufacture; in other instances only the minimum clearances are given in the Maintenance Instructions Manual requiring the tool to be locally designed and manufactured.

As previously mentioned in this chapter, the tools and equipment required to properly boresight an aircraft will vary considerably, depending on the specific model of aircraft being boresighted. The Maintenance Instructions Manual is the most readily available source of information on tools and equipment required as well as correct procedures, and should be referred to early in the first step of planning a boresighting program and followed throughout the entire program.

FIRING-IN ALINEMENT

After the guns have been boresighted, the final accurate gun alinement should be made in order to place the mean point of impact of each gun in its desired area. This may be accomplished by use of a screen designed for the purpose. Where boresighting has been accomplished at the butts on a boresighting range, the fire-in procedure is somewhat simplified, as no further alinement of the aircraft to the target is usually required.

Before firing-in, the ordnanceman in charge of the boresighting crew should perform a projectile clearance check, insure that all the boresighting instruments used are accounted for, and that the guns are free of obstruction. All safety precautions concerning the firing of guns shall be strictly adhered to. Only ammunition of the type approved for test firing will be used.

The firing-in steps are prescribed in the Armament Section of the Maintenance Instructions Manual for each model of aircraft and should be followed. Firing-in usually consists of a battery burst of 20 rounds. The target screen is then analyzed and the necessary adjustments made. This procedure is repeated until optimum results are obtained. NOTE: After any adjustment, a projectile clearance check must be made before the gun is fired.

LAUNCHER ALINEMENT

In the majority of installations launcher adjustments are limited to adjustments in the vertical plane which are normally accomplished by shimming under the launcher or mount. Horizontal corrections are usually confined to calibration, where the system is checked to determine if the launcher is alined within acceptable tolerance. In any case reference should be made to the applicable Maintenance Instructions Manual before alinement is attempted.

MISCELLANEOUS CONSIDERATIONS

CARE OF BORESIGHTING EQUIPMENT

Boresight target screens, in addition to having to be laid out and constructed with meticulous care, have to be handled and stored with care. If the screen is broken or distorted, it loses a great deal of its accuracy, and is likely to give erroneous results during boresighting.

There are a number of highly specialized tools used exclusively for boresighting. They should never be allowed to go adrift and should have specified stowage spaces capable of being locked.

The boresighting kits furnished to operating units are precision optical instruments, and should be handled with this fact in mind. Any distortion of the settings of the components, misalinement of the optical components, forcing of threaded joints and elbows, and damages to the optical surfaces will render the instrument useless. Erroneous results will follow any attempt to boresight guns with a boresight kit that has been damaged.

It should be a hard and fast rule that all jacking and hoisting equipment used in boresighting be thoroughly inspected prior to its use. The equipment should be in perfect working condition as failure of any one of the components may well result in extensive damage to the aircraft and injury to boresighting personnel.

PREPARING BORESIGHT SCREENS

The details of constructing a boresight target screen have been previously given. However, accuracy in laying out the boresight points cannot be overstressed if the guns and other armament are to receive the proper boresighting. Screens are normally constructed to be used at close range. Wherever possible long range boresighting should be used in the interest of accuracy. If an error were made in laying out any of the boresight points for a screen which is to be used at a short distance from the aircraft, the error at firing ranges would be tremendously magnified. The target would not be missed by inches; it would be missed by feet despite the fact that the pilot had tracked smoothly and fired only when squarely "on."

POINTS TO CHECK WHILE BORESIGHTING

During boresighting of the guns or other armament equipment, a number of troubles may be experienced. To help eliminate these troubles check the following items prior to and during boresighting:

1. That the chamber of all guns are empty.
2. Cleanliness of the guns. The guns may not have been cleaned, thus causing the boresight to fit improperly.
3. Proper operation and condition of the guns. There may be broken or distorted parts in the gun. A gun badly eroded at the breech or muzzle would cause an improper fit of the boresight element.
4. Correct boresight target screen. The boresight target screen may be the wrong type for the aircraft being boresighted.
5. Correct position of the aircraft and boresight screen. The aircraft may not be properly positioned for boresighting, and this fact may

not be noticed until too late, causing all previous work to be repeated.

6. Accuracy of the boresighting operation. Guns may inadvertently be boresighted to the wrong boresight points on the screen. In some installations this fact may show up when trying to replace the nose cowling, and a binding occurs as the blast tube strikes the gun muzzle instead of slipping over it. In other installations this condition may not show up at all.

7. Accuracy of the gunsight alinement. The gyro reticle may have been used to aline the gunsight with the target instead of the fixed reticle, thus introducing an error.

8. Condition of boresight fixtures. The boresight brackets and their sights attached to the aircraft may be bent or broken.

9. Condition of the gun mounts. Boresighting procedure may be accomplished in spite of the fact that the gun mounts are defective, broken, or misalined. New mounts will have to be installed and the boresighting repeated. Always check the mounts prior to boresighting.

10. Condition of the gunsight. The gunsight may be out of collimation, and the crewmember boresighting the unit may not look through the sight from exactly the same eye position each time. The sight must be corrected or replaced and the boresighting repeated.

11. Safety wiring of all adjustments. Someone may have forgotten to safety wire some of the adjustments during the boresighting process. A careful check on this point is a necessity.

SAFETY PRECAUTIONS FOR BORESIGHTING

There is danger associated with all phases of ordnance work. Boresighting is by no means an exception. Boresighting may be conducted safely only when those participating in the work are able to recognize and understand the causes and effects of all the real and incipient dangers associated with this work, and are thereby able to avoid and prevent their occurrence. Listed below are some of the precautions which should invariably be taken in connection with boresighting. Some of these may seem inconsequential, but are generally found to be more far-reaching than at first supposed:

1. One of the primary precautions is to insure that all personnel concerned have a complete understanding of the operation of boresighting. This does not necessarily mean that the man whose only job is driving the tractor should know how to boresight all the guns on an aircraft. However, it does mean that those whose job it is to boresight the guns should know all of the procedures and safety precautions therewith associated and be qualified and certified in accordance with OpNav Instruction 3571.3.

2. Remove all external loads such as bombs, rockets, and internal stores in the bomb bays.

3. Use only tractor drivers who are thoroughly checked out, and use the proper towing gear in each instance.

4. Make use of elevated platforms or other types of check stands so that boresighting personnel may avoid clambering over the aircraft during boresighting.

5. Check the output voltage of the external power units.

6. Stay clear of the line of fire at all times. Even when boresighting from the muzzle with the bolt group removed, this practice should be enforced.

7. The boresighting crewmember in charge should personally check to insure that the feed mechanisms are disconnected, and chambers are empty each time before allowing the breechblock assembly to go forward into battery.

8. Never mechanically block or electrically "jump" the disabling switch. This device is placed in the gunfiring circuit for making the guns safe whenever the landing gear is lowered, either in the air or on the ground.

9. The breechblock assembly should be in its aft position or removed from all guns being boresighted.

10. Insure that the jacking and hoisting equipment to be used in boresighting is of sufficient capacity (plus a safety margin) for the job at hand.

11. Always use the safety locks on the hoists and jacks once the aircraft is in the proper boresighting position.

12. While jacking an aircraft, check the jack feet to insure that the load weight is being evenly distributed and that the jacks do not become off balance. (Jacking should only be performed under the supervision of a senior AMS.)

13. The jack pads should be checked during the jacking process to insure that no slippage or shifting of weight occurs.

14. Always handle the boresighting kit carefully as it is precision made optical equipment, and therefore very delicate.

15. If test firing is to be conducted to check boresighting, have sound powered

communication equipment installed in the butts and at the aircraft site to expedite operations and serve as a safety measure.

16. When an aircraft is being boresighted or its guns being test fired while on a ramp, serviceable chocks have to be carefully fitted in place about the wheels and the aircraft properly secured.

17. Before boresighting or test firing the guns, check the gun mounts for worn components, security, and proper installation. Also check to insure that the guns are actually locked into the mounts.

18. Before firing-in make proper projectile clearance checks, repeat these checks each time any adjustment is made on a gun prior to firing.

19. In organizing the crews to boresight aircraft armament, limit the personnel only to those essential in the actual boresighting work and those who must observe for training purposes.

20. After boresighting has been completed, safety wire all adjustable elements or otherwise secure them to specifications, and check the aircraft compartments for tools and equipment that may have gone adrift during the work.

21. Always check to insure that all the boresight elements are back in the boresighting kit after boresighting is completed. Instances have occurred in which the boresight adapter and muzzle elements have been left in the gun muzzles with fatal results to personnel.

It is hard to find time and incentive to lay proper emphasis on safety precautions due to the commitments of daily routine operation and other distractions, yet accidents occur daily while carrying out these same routine operations. The obvious remedy to correct for such a condition to the greatest possible extent is to find time and impress on each person involved the seriousness of knowing, understanding, and complying with all pertinent safety precautions. The more a man knows about the why's and wherefore's of safety precautions, the less he is likely to forget the precaution itself. For instance, never simply tell him to lower the jacked-up aircraft at the same rate at each jacking point. Give him the whole story about lowering too rapidly on any one of the jacks. Tell him of the relative ease with which an aircraft can be and has slipped off the jacks when raised or lowered unevenly. Make sure he knows he may do strike damage to the aircraft and kill himself as well. This is an elementary example, but when it comes to safety, a lot of us never get out of the elementary grades!

CHAPTER 11

SMALL ARMS RANGES

AUTHORITY FOR RANGE INSTALLATION

The small arms range is a familiar physical element of the naval shore station. Its presence is more or less taken for granted by those assigned to the station and even visitors to the station. Quite often there are several ranges within the confines of the station. There may be one for rifle, another for pistol, another for automatic weapons, and still another for skeet. Certain of these types may be combined into a single range. There are other types of ranges which serve highly specialized purposes, such as those for training troops to maneuver under actual fire. The latter types require the troops to crawl over the ground while machineguns are actually fired closely over their heads. It may be seen that the small arms ranges offer a diversified training. Although these ranges may be taken for granted by many, a great deal of planning, designing, expenditure of effort and money, and many other factors are involved in procuring authorization to construct and to operate these ranges.

The primary purpose of constructing small arms ranges is to afford adequate provisions for qualifying and requalifying military personnel in the safe handling and effective firing of all types of small arms. Small arms are indispensable items of warfare. Most men do not possess a native ability to handle and fire these weapons properly. As a consequence, they have to be taught both these feats. To safely handle, to accurately fire, and to tactically employ small arms in a correct manner are the primary aims of all training concerned with small arms usage.

Small arms ranges of the Navy are constructed with appropriations from the Congress. Because of this fact, the Chief of Naval Operations has directed that not only shall these ranges be made available to all branches of the military but, in addition, to all able-bodied males capable of bearing arms under reasonable regulations prescribed by the controlling authorities. Hence, it is the policy to promote interest in small arms marksmanship in civilian rifle clubs and to aid in the training of civilians in the common defense of the United States. Further, commanding officers are strongly encouraged by this policy to extend the privileges of the ranges under their supervision to local police clubs, local pistol and rifle clubs of civilian membership, and other clubs chartered by the National Rifle Club of America. The only restrictions to such employment of the military ranges are that these clubs will incur no expense to the government during the course of their usage of the ranges, and that they in no manner interfere with the regular training of the military personnel.

Recruit training in small arms is conducted by the Navy so that each new member of the service is afforded the opportunity to learn how to shoot and to become proficient with these dangerous weapons. Military personnel are required to requalify in small arms at specified periods in order to maintain their proficiency. This applies to officer and enlisted personnel alike. The training must be thorough. Any training in this area short of thorough is dangerous and wasteful. Certain military personnel require more advanced study and practice in the use of small arms than others. This fact exists because certain personnel, by the nature of their duties, will have more occasion to employ these weapons than others in the service. Such members will have duty in landing parties, security watchstanding, aviation and construction battalion crews, and may even be members of the Naval Emergency Ground Defense Force (NEGDEF). About 20 percent of the naval personnel billeted ashore should be completely trained in the use of small arms as this is roughly the percentage necessary for watchstanding and other duties of like nature.

History has clearly revealed that nations which aggressively support all types of civilian ranges, have adequate ranges for the military, and sponsor many marksmanship contests have always been outstanding in the prosecution of wars. Small arms still continue to be a heavily weighted factor in winning a war despite the tremendous increase in new and more devastating weapons. A nation with a good percentage of its population trained in effective usage of small arms is at a decided advantage over those without in the event of war and as a general deterrent to war.

The National Rifle Association of America has been supported in part by the Congress most of the years since 1902. It enjoys much prestige and vast membership through the United States. Its chartered clubs compete in tournaments in which thousands of shooters compete for national honors.

At the core of the Navy markmanship program is the Small Arms Training Unit and its match-conditioning shop, located at the Navy Training Center, San Diego, California. Its mission covers the range of Navy marksmanship from developing instructors, research of new ideas in competition, and techniques of shooting to originating improvements in competitive small arms. Aviation Ordnancemen and Gunner's Mates (E-5 and above) are trained here to provide maximum instructor support to activities which have extensive small arms training requirements.

The criterion for Navy marksmanship training is to foster increased interest on the part of naval personnel in a basic military skill through competitive exercises, thereby extending the scope of regular small arms training. The rationale on competitions is based on the precept that a part of the military man's professional skill must include the ability to handle small arms and that competitions make it more instinctive for the navyman to react properly under stress.

For the navyman who has the skill for and interest in competitive shooting, the Annual Small Arms Training Competitions offer a chance to demonstrate his prowess. These competitions are planned and scheduled so that from them strong U.S. Navy teams can emerge to compete in the interservice, national, and international competitions.

Commanding officers are encouraged to conduct rifle and pistol competitions to the fullest extent that time, facilities, and ammunition allowances will permit. The rules and regulations governing the competitions are found in OpNav Instruction 3590.7 (Series).

TYPES OF RANGES

After a small arms range facility has been constructed and is ready for use, it is manned by personnel assigned by the commanding officer of the station. A range officer or petty officer is assigned to and made responsible for the overall operation of the range, for its internal security, and safety for all hands concerned. Ordnance strikers and petty officers are assigned in sufficient numbers to carry out the necessary work and to administer the details of the range. Certain members of the crew are assigned primary duties which involve instructing the trainees in the safety precautions necessary and conducting indoctrinational lectures from approved syllabuses. These lectures will cover such areas as safety precautions to be employed in the use of each type of small arm, types of courses to be fired, scoring, functioning principles of the arm concerned, range etiquette, duty in the butts, proper stance and positions for firing, trigger squeeze, employment of slings, spotting scopes, pasting targets, and many other items pertinent to proper utilization of small arms.

PISTOL RANGES

Navy pistol ranges are standardized only to the extent that they incorporate 50-foot, or 25-yard or 50-yard positions from which the different courses may be fired.

RIFLE RANGES

U.S. Rifles, Caliber .30, Caliber 7.62-mm, Model M2, and Caliber 5.56-mm, Model M16, are currently the standard service rifles of the Navy. They are fired normally for marksman, sharpshooter, and expert on ranges of 200, 300, and 600 yards. The .30 caliber carbine is also fired.

SMALL ARMS COURSES

Standard courses for rifles, pistols, and revolvers, submachine guns, ground machineguns, and automatic rifles are listed in tables

11-1 through 11-5. These courses are established by the Navy Small Arms Markmanship Manual and must be used for record firing. However, the officer in charge may vary or adjust these courses to fit available range conditions.

GENERAL CONSIDERATIONS

Specifications for the construction of small arms ranges for the Navy are available in NavFac DM-27 (design manual). These specifications give in detail the basic range construction with regard to size; measurements of firing positions from the targets; shape, size, and facial inclination of the bullet stop (butt); layout of range components in general; desired terrain (natural) conditions; and other considerations of range installation. Once the range facility is constructed and in use, upkeep and maintenance then becomes the primary considerations.

A well-kept small arms range is an asset to any naval station. To maintain a range properly will assure that it always has a well-kept and neat appearance. Maintenance on all types of small arms ranges varies only to a minor degree. Such variance existing is usually brought about by the relative sizes of the ranges. It is somewhat harder to maintain a rifle range which may extend over several hundred yards than it is to perform the same type of work on a pistol range which covers from 25 to 50 yards.

Targets for small arms firing are all of prescribed dimensions for the types of arms and the courses to be fired. The devices which support and display the targets and placed in the butts are not standardized to any particular degree. Basically, the supporting devices are constructed from wood in those parts which show above the ground level and are consequently exposed to fire. Those parts below ground level in the butts are quite often constructed from angle iron and pipe. The wooden frames above the ground are faced with a material similar to cheese cloth to which the targets are secured. Certain ranges incorporate target supports which may be rotated from the firing line. Maintenance to the target supports consists mainly of repairing or replacing the wooden frames when damaged by gunfire.

Rifle ranges incorporate a trench (known as a pit) parallel to the butts which allow personnel to remain at the targets during firing in order to mark and paste the targets. This pit is deep enough to protect even a tall man while standing. In addition to this depth of the pit, there is normally a low mound of earth near the firing line side of the pit for added protection. A telephone system is installed between the firing line and the butts. This system acts both as a safety device and a means of expediting the firing of the courses. Personnel in the butts during firing are under the direct supervision of an experienced man (chief pit officer)

Table 11-1.—Service Pistol Qualification Course A.

Range (yards)	Time	Rounds	Target	Type of fire
25	None	10	Standard American 25 yds RF and TF.	Slow.
25	20 sec	*10	Standard American 25 yds RF and TF.	Timed.
25	15 sec	*10	Standard American 25 yds RF and TF.	Rapid.

*Time allowed is for one 5 shot magazine.
Total shots record firing—30. Maximum score—300.
Qualifying scores: Expert—225, Sharpshooter—200, Marksman—180.

NOTE: Where adequate facilities do not exist to fire Course A at 25 yards for expert qualifications, the use of the International 50-foot pistol target at a 50-foot indoor range is permitted.

Table 11-2.—Service Rifle Qualification Course B.

Range (yards)	Time	Rounds	Target	Position	Sling
200	2 min	**2	A	Prone	Loop
200	5 min	5	A	Prone	Loop
200	70 sec	*10	A	Prone from standing	Loop
200	5 min	5	A	Sitting	Loop
200	70 sec	*10	A	Sitting from standing	Loop
200	10 min	10	A	Standing	Hasty

*Two rounds initially loaded for M1; two magazines with 5 rounds each for M16.

**Sighting shots. Do not include in total score.

Total shots record firing—42. Maximum score—200.

Qualifying scores: Expert—170, Sharpshooter—160, Marksman—140.

NOTE: Where adequate facilities do not exist to fire Course B at 200 yards for expert qualifications, the commanding officer may vary or adjust this course to fit available range conditions (e.g., if a 100-yard or 1,000-inch range is the maximum available, use appropriate reduced target).

who directs their activities from his position in the butts in accordance with instructions given by the range officer at the firing line. He also insures that all safety precautions are strictly observed by the personnel in the butts attending the targets. Machineguns may also be fired on this type of range. Targets and firing procedures will necessarily have to be altered to the appropriate ones for the machinegun.

The areas between the firing positions and the targets of the pistol ranges are, where practicable, sodded or planted with some specie of vegetation which will grow best in that particular climate. Occasional trimming and watering are necessary to keep this vegetation at its best, both for appearances and for its ability to slow down wild shots which may strike the ground short of the butts. Rifle ranges which extend over several hundred yards need not be sodded. Usually, natural wild vegetation will take over a newly constructed range and has to be kept trimmed for neatness and good visibility of the targets.

The shooting positions, or firing lines, are quite often elevated above the surrounding areas for reasons of good drainage after rains and for better visibility. They are smooth, level, and at exactly the prescribed distances from the targets.

There are many other features which add to the effectiveness of the range and the comfort of the shooters. Benches, water fountains, sunshades, gunracks which may be transported from course to course, sidewalks, stands for arms and ammunition, firing line canopies, range officer's stand, range buildings, and protective bulkheads are some of the features often added to the basic range design.

In general, maintenance of all types of ranges consists of repairs to and painting of wooden components, repairs and painting of metal components, regular policing of the areas for trash and articles adrift, trimming of grass, replacement of targets and their cloth supports, and repairs and lubrication of any mechanical features incorporated.

INDOCTRINATION AND INSTRUCTION

There is an old saying that "good shots" are born. We know today that this is not quite the truth. The methods by which service personnel have been taught to accurately fire all types of small arms have been thoroughly tested over the years. One conclusion to be drawn from records kept by the services is that anyone may be taught to shoot accurately. There is no denying that perfect coordination of muscles, nerves, brain, and eyes materially aid in shortening the training period necessary to produce a highly qualified shooter. But by proper training, anyone may become a good shot.

Table 11-3.—Submachine gun course.

Range (yards)	Time limit	Shots	Target	Position	Type of fire
200..........	10 min..........	10	B	Prone	Slow.
100..........	25 sec..........	10	3 A (1)	Standing to sitting-	Semiautomatic.
25..........	10 sec..........	15	3 A (2)	Standing, gun at hip until commence firing.	Automatic.

(1) Three targets, rifle A, 10 feet apart. No hit outside of the 4 ring is scored. Fire should be distributed; deduct 10 points for any target not hit inside the 4 ring. In applying penalty, no score shall be less than zero at any one range.

(2) Three targets, rifle A, 5 feet apart. Same scoring and penalties as above.

Total shots record practice—35. Maximum score—175.

Qualifying score—100.

Table 11-4.—Ground machine gun course.

Range (yards)	Time limit	Shots	Target	Type of fire
200..........	None...........	10	B	Bursts of 3 to 5.
200..........	35 sec..........	20	B	Do.
200..........	20 sec..........	20	B	Do.
500..........	None...........	10	B	Do.
500..........	40 sec..........	20	B	Do.
500..........	20 sec..........	20	B	Do.

Total shots record firing—100. Maximum score—500.

Qualifying score—260.

Quite often the major hindrance to a person becoming a good shot stems from bad shooting habits picked up through self-instructions. A person with this trouble attempting to qualify in small arms will have a harder time than a person who never had a gun in his hand. The bad shooting habits have first to be completely eradicated by the instructor before the self-instructed shooter is finally on an even footing with the beginner. It has been proven many times that, with the present training methods, the man who has developed bad shooting habits may successfully be "converted" into a good shot.

The services have found that one method of instruction should be used. Although another method might prove just as effective, it is not a good idea to use two methods of training because a great loss of time and effort is caused

Table 11-5.—Automatic rifle course.

Range (yards)	Time limit	Shots	Target	Position	Type of fire.
200..........	10 min..........	10..........	B	Prone with sandbag rest.	Single shots.
200..........	20 sec..........	10..........	B	Prone..........	Semiautomatic.
200..........	25 sec..........	*3 strings of 10.	B	Sitting.........	Do.
500..........	10 min..........	10..........	B	Prone	Single shots.
500..........	80 sec..........	40..........	B	Prone	Semiautomatic.

*25 sec. per string of ten.
Total shots record firing—100. Maximum score—500.
Qualifying score—300.

by transfers from one method to the other. For this reason, one method has become standard throughout the services.

PREPARATORY EXERCISES

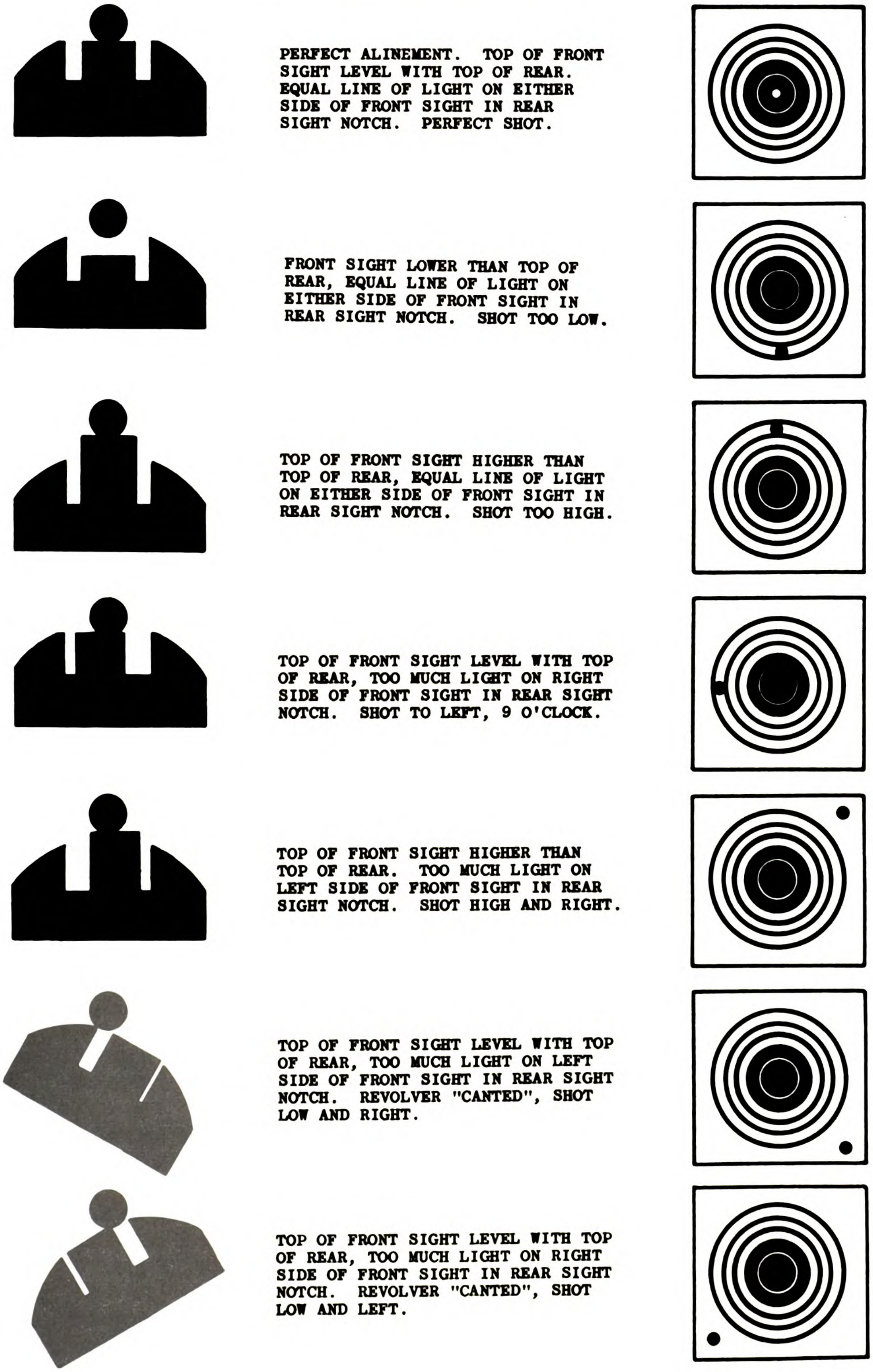
Essential operations in these exercises are taken up in a specific order. The first exercise is to learn the proper alinement of the sights of the small arm. Basic principles of correct sighting are shown in figure 11-1.

Although this figure depicts sidearm sights, the same sighting principles hold for any small arm with open sights. After mastering this, proper holding of the arm is taught. After this, comes the trigger squeeze. This is quite often the most difficult of all phases to master, but it is the most important of all. Each phase above has to be mastered to the extent that it may be performed without completely absorbing the attention of the trainee from the other phases which have to be performed concurrently. This is a fine point of instruction in the overall picture. Each new step is added to the previous one in practicing so that the earlier steps are not forgotten and the trainee may see and feel how each step leads to the next. Then, manipulation of the arm and firing exercises follow. Finally, an examination is held which covers all that has previously been given and learned. The trainee is not allowed to go on to the firing phase of training until he has mastered all the preparatory exercises.

In the firing phase of instruction, there are still preparatory exercises to be learned before actual firing of the weapon is permitted. Only after the instructors are sure that all trainees have learned all preparatory exercises so that they can perform them without hesitation will they be allowed to load ball ammunition and fire at targets. It has been found essential that the trainee be taken from the preparatory phase into and through the firing phase without a break in his instruction. The combined effect of both the preparatory exercises and the range firing is necessary for the formation of correct shooting habits.

FIRING PROCEDURES

Safely conducting a small arms practice of record firing requires a definite set of firing procedures. This is true whether qualifying trainees or requalifying more experienced men. Firing Commands have to be given in order to insure that all men on the firing line will do the same thing at the same time and with the maximum safety possible. These commands have to be given in a loud clear voice and in language easily understood by all hands concerned. The trainees are familiarized with such commands throughout their classroom and range work.



PERFECT ALINEMENT. TOP OF FRONT SIGHT LEVEL WITH TOP OF REAR. EQUAL LINE OF LIGHT ON EITHER SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. PERFECT SHOT.

FRONT SIGHT LOWER THAN TOP OF REAR, EQUAL LINE OF LIGHT ON EITHER SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. SHOT TOO LOW.

TOP OF FRONT SIGHT HIGHER THAN TOP OF REAR, EQUAL LINE OF LIGHT ON EITHER SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. SHOT TOO HIGH.

TOP OF FRONT SIGHT LEVEL WITH TOP OF REAR, TOO MUCH LIGHT ON RIGHT SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. SHOT TO LEFT, 9 O'CLOCK.

TOP OF FRONT SIGHT HIGHER THAN TOP OF REAR. TOO MUCH LIGHT ON LEFT SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. SHOT HIGH AND RIGHT.

TOP OF FRONT SIGHT LEVEL WITH TOP OF REAR, TOO MUCH LIGHT ON LEFT SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. REVOLVER "CANTED", SHOT LOW AND RIGHT.

TOP OF FRONT SIGHT LEVEL WITH TOP OF REAR, TOO MUCH LIGHT ON RIGHT SIDE OF FRONT SIGHT IN REAR SIGHT NOTCH. REVOLVER "CANTED", SHOT LOW AND LEFT.

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Figure 11-1.—Effects of correct and incorrect sight alinement.

There are more or less standard commands to be given by the range officer or petty officer conducting the practice or qualification firing. These commands will vary from one small arms facility to another, and for different types of weapons being fired. As a result, no cut and dried set of commands exist as such.

Basically, the initial command given for the standard service rifle prepares the shooters for firing by ordering them to load and lock their weapons. Upon completion of firing, or after a specified time interval, all hands are commanded to "clear and lock all weapons." These basic commands may not be used for all types of small arms firing. However, they must be amplified to meet the exact needs of the various types of courses to be fired, types of weapons being fired, and to prescribe to local conditions.

An example of the commands given during a pistol firing, for instance, is given in table 11-6.

Table 11-6.—Firing line procedures.

Basic range commands	Action taken
1. First relay on the firing line.	First relay previously assigned take positions on firing line.
2. The preparation period starts now.	First relay may not handle their pistol until they have taken their position at the firing point and this command given.
3. On the firing line, load.	Shooters face the targets keeping weapons pointed down range at all times, finger out of trigger guard, insert magazine, and release slide.
4. Is the line ready?	Any shooter who is not ready or whose target is not in order will immediately raise his arm and call "not ready on target ." The range officer will immediately investigate the difficulty and assist in correcting it. When the difficulty has been corrected, the range officer calls "The line is ready."
5. The line is ready.	Given after firing line is ready.
6. Ready on the right.	Shooters may point weapons at targets (range officer checks to insure that all shooters are ready).
7. Ready on the left.	Same as No. 6.
8. Ready on the firing line.	Targets exposed or signal to fire is given in approximately 3 sec.
9. Commence firing.	Firing now commences in accordance with previously determined plan. The type of fire may be slow, timed, or rapid.
10. Cease fire, magazine out, slide locked back, and/or cylinder out, bench weapons.	Each shooter stops firing the instant he hears this command, keeps his weapon pointed at the butts, removes magazine and/or unspent rounds, checks breech to insure that it is clear, and safeties the weapon. Finally he places the weapon on the rest and steps back one pace.

The range officer may then command the shooters to go forward to either mark or observe marking of their targets, depending on the progress of the exercise being fired. A jammed weapon during the course of firing an exercise is handled in accordance with instructions given in class or prior to going on the firing line.

One safety feature which is invariably used at any and all small arms ranges during firing is the raising of a red flag (Bravo flag) over the range. The flag, at the peak of its mast, is clearly visible to all at, near, or approaching the range facility.

The monotony of repeating a simple operation is a limiting factor in the length of time a trainee should be forced to continue preparatory exercises. Roughly, 15 or 20 minutes at any one time is all a trainee will be able to practice aiming, holding, and dry firing the gun. Skillfully introduced changes to procedure by the instructor may materially lengthen this period of attentiveness. The idea is to compel the trainee to perform the exercises until all actions become habitual without causing the whole instruction to become a monotonous and distasteful task. Two weeks of continued practice is considered a minimum in which to prepare the trainee for actual firing and to form correct shooting habits. Some will require more time. Even though the manner of correct performance of the essential operations has been thoroughly learned, the trainee will take at least a week on the firing line to solidly fix the habit of correct performance of these operations within his mental and physical makeup.

During small arms instructions the trainees are divided into pairs; one is the "shooter," the other the "coach." The instructor alternates the trainees between these two jobs. The "coach" observes the performance of the "shooter" and vice versa. This routine provides frequent changes in procedure which prevent loss of interest, constant supervision of a personal nature, corrects bad habits as they show up, shows the trainees graphically their own mistakes, and tends to develop the ability of the trainees as instructors.

Another division that is necessary among the trainees is that of forming a number of groups of conventional size to be adaptable to the best training procedures. A squad similar to that found in the Navy Emergency Ground Defense Force (NEGDEF) is considered to be highly adaptable. Each group is under the direct supervision of a group instructor who is usually a petty officer from the same division as the men under instruction. These group instructors are, or should be, specialists trained in the instruction of small arms. Over these instructors will normally be an officer in charge of instruction who coordinates all instruction and lays out the work.

The methods of instruction are standardized in three steps: First, to explain to the men under instruction the reasons for the training as well as the necessity for it; second, to give a demonstration of the work to be covered by steps; and third, to exercise the men in work laid out for the steps. Step one tells the men what they should do—not what they should avoid—and stresses the necessity for exactness in the performance of all operations. Step two establishes a routine in which the men are divided into pairs and each man in these pairs alternates in the performance of the exercises. Finally, step three carries out the exercises by groups under group instructors in the same manner as has been demonstrated previously. Close supervision is given by the group instructors and the officer in charge of instructions.

SMALL ARMS EMPLOYMENT

Not all naval personnel are instructed and qualified in all types of small arms. This is not practicable. However, some personnel, due to their presumptive duties, will receive the full course of instructions in all types of small arms. It may be said then that the average man will receive training and qualify in one or more types of small arms. Recruits at training stations are given a thorough course in rifle and pistol marksmanship. All other men entering the service should get this training also. The types of small arms used by the Navy are the rifle, revolver, pistol, carbine, submachinegun, automatic rifle, machinegun, and the shotgun. Some of these general classifications of small arms have one or more differing types of arms under each classification. A discription of all the small arms used by the Navy will be found in Aviation Ordnanceman 3 & 2, NavPers 10345-C.

SMALL ARMS FIRING

Each type of small arm requires a different technique in being properly fired. However, if one is to effectively fire any weapon, it is necessary to master certain basic techniques common to the firing of all small arms. The proper trigger squeeze, the assumption and holding of proper firing positions, correct sighting, and muscular relaxation are basically the same for all firing. The standing positions from which to fire the pistol and the rifle are not identical, but they are basically enough alike to be treated the same as far as stance, trigger squeeze, and relaxing of muscles are concerned. A person who masters these basic techniques is well on his way to becoming a good shot with any type of small arm.

In the firing of small arms, certain regulations and responsibilities immediately become importantly evident. The discharge of any weapon in populated areas has to be strictly supervised. Someone must set forth the regulations covering the firing, see to it that they are scrupulously carried out, and assume the responsibility for safety to all hands.

Further information on firing is found in the Navy Small Arms Marksmanship Training Manual, NavPers 93863.

REGULATIONS

Regulations may consist of anything from orders for posting range sentries to the proper manner in which to fire from the prone position. While firing positions may be thought of as techniques or procedures, they are still standardized regulations. These positions have been developed after much experimentation and are regulations to the techniques of correct firing. Other regulations are concerned with the manner in which each small arm is to be handled and fired; the exact distances over which various courses are to be fired; the safety precautions pertinent to arms, ammunition, and the handling of both; and the number of hours, or study sessions, necessary to prepare the trainee for the firing phase of small arms qualification. There are a multitude of others, but the above indicate the diversity of their coverage.

Some of these regulations originate from the Secretary of the Navy. Such general regulations and responsibilities are found in the Landing Party Manual, United States Navy 1960 (latest change). Others come from the Naval Ordnance Systems Command and District Commandants. Still others originate at local levels, such as commanding officers of naval stations having small arms ranges. Even the officer in charge of the range will feel the need for certain regulations covering specific local conditions. Quite often even the instructors will see similar needs. When drawn up and duly authorized by the commanding officer, they become just as much a part of local regulations as do those from higher authority.

RESPONSIBILITIES

Responsibilities connected with administration and operation of a small arms range are not all assignable to any one person although the officer in charge of the range has the final responsibility, to the commanding officer, for the range. Responsibility for safety and the proper conduct of firing exercises lie with all hands concerned. If a "coach" notices a dangerous situation on the firing line, it is his responsibility to take immediate steps to correct it. If the group instructor notes an omission in the training syllabus, it is his responsibility to bring it to the attention of the officer in charge of instruction or the officer in charge of the range. Among his other responsibilities, the range officer is responsibile to bring to the attention of his commanding officer any discrepancies noted in the overall physical plant, shortcomings in the training, and other personnel and material problems. These are all merely examples to illustrate the fact that acceptance of and attention to responsibilities are mandatory to all hands concerned with any undertaking.

The range officer delegates authority down the line. Those involved automatically accept certain responsibilities in connection with the authority delegated to them. On the proper discharge of these responsibilities depends the successful conduct of the undertaking.

USE AND MAINTENANCE

In order to use the various targets on the rifle range, it is necessary to attach them to target frames. This is usually accomplished by pasting or using a staple gun. The frames are then set into their metal supports, two to a supporting device. These devices are constructed so that the targets may be easily raised and lowered. The weight of one target frame counterbalances the weight of the other, thereby necessitating a minimum of effort in raising one and lowering the other. The supporting device (target carrier) is fashioned from iron angle members and plating. A system of sprocket wheels and chains raise one target while lowering the other as the frames ride in channels provided to assure adequate rigidity and ease of operation. Metal structures are always placed below the line of fire down in the butts to prevent dangerous ricochets.

A well-organized and smoothly operating range will have sufficient targets of all kinds, paste, target spotter disks, spindles, cloth, pasters, and other devices on hand and ready for use. Closely adjacent to each man marking targets should be sufficient materials needed to "paste" targets. These materials should be neatly stowed in a box or on a ledge where they will not become adrift and where they may be protected from deterioration. As the targets are pasted one over the other during firing, care should be exercised not to allow them to build up to a point at which they become too heavy and peel or fall off. Remove the old ones prior to that time and replace them with a new single target. While pasting or fastening targets to their frames with a staple gun, insure that they are securely fastened against wind damage.

It may be necessary to replace the target cloth fastened to the target frames after many punctures by the projectiles. This material is cut and fastened to the wooden frames with staples. Also, the frames themselves are heavily damaged by gunfire. They should be replaced before they become unfit or dangerous to use. All metal frictional surfaces should be well lubricated and other portions preserved to prevent rust. Pistol ranges often have been fitted with means of moving the targets 90° from the line of fire remotely. These devices are constructed of metal in the main and have to be hidden low in the pit to prevent accidental ricochets. Only the targets and their wooden frames show above ground as with the rifle target devices.

Good working conditions aid in smooth operation of a range. Therefore, it is necessary to police the areas including the butts and firing lines at intervals during the progress of an exercise. Old targets, pasters, wooden splinters, and other debris should be systematically cleaned up—not allowed to accumulate. "Brass" on the firing lines will be picked up periodically and placed in receptacles provided for the purpose of saving the spent cases. Areas between the firing lines and the butts and adjacent thereto should be kept clean of paper, trash, undergrowth of sufficient height to bother the shooters, and other foreign articles. Neatness of the range devices and structures is heightened by painting. Painting also serves the important task of helping to prevent corrosion of metal parts and rot in wooden fabrications. Grass and other vegetation is very helpful in stopping wild shots. It should, therefore, be encouraged to grow into thick carpets between the firing lines and the butts.

SMALL ARMS AMMUNITION

ALLOWANCES

Ammunition for preliminary training and for qualifications is limited. Only certain allotments can be made for the above purposes; therefore, all ammunition for small arms training must be wisely expended. It is necessary that preliminary training be conducted with great care and thoroughness so that firing for qualification may be performed without exceeding allowances.

Current information on small arms ammunition training allowances may be found in OpNav Instruction 8011.6 (NOTAL) Series and NavOrd Instruction 8011.5 Series (current revision or their supersedure), plus any other lists or instructions deemed necessary by Naval Ordnance Systems Command.

PROCUREMENT

Ammunition used for practice, for record firing, and unless otherwise authorized, for competitions is the regular ammunition issued to ships and shore stations and designated for such use by the Naval Ordnance Systems Command.

The ammunition issued by NavOrdSysCom is necessarily of many different lot numbers. Therefore, it is highly desirable that the same lot number ammunition used by a particular individual in his practice firing also be used for his record firing. Consistent results in firing are much easier to obtain using the above procedure than when the lots are mixed for practice and the record firing. When competitions are fired, it is only fair that all contestants be issued the same lot number ammunition. It has been found through experience that there is a definite relationship between the thoroughness of the preliminary training of the individual and the average number of rounds he needs to actually qualify. Good training in the preliminary stages usually prepares the man to qualify by expending the absolute minimum number of rounds.

In controlling small arms ammunition, the Ships Parts Control Center (SPCC) screens reports of ammunition from the field for evidence and cause of its becoming unserviceable. SPCC Notices are sent to commands known or suspected of having defective ammunition. These notices suspend from issue, by lot number, all such ammunition deemed unserviceable. Subsequent instructions from the SPCC order specific disposition of the defective lots. Publications are issued which set up allowances of ammunition for everything from the various services down to the individual man. The Navy and the Marine Corps will have established for them certain allowances of ammunition, service teams at competitions will have certain allowances, and an individual representing the service at a competition will have a specified allowance of rounds. Allowances are set for all contingencies. NavOrd Lists are the authority for such allowances. NavOrd Instructions contain further breakdowns of allowances for specific instances and conditions. Reserve components of both the Navy and Marine Corps are covered in the allowance lists and allowances of ammunition are based on the number of men in each unit.

RECORDS, REPORTS, AND MEDALS

Strict accounting of all ammunition used in the services has to be maintained. As a result, periodic reports related to quantity, serviceability, inventories, expenditures, etc., are mandatory. Reports are made on standard forms provided for that purpose. They are directed to Ships Parts Control Center, Commander Naval Ordnance Systems Command, and others concerned.

SMALL ARMS RECORDS

The records used for small arms ranges are concerned with information necessary to be recorded at the firing lines and in the pit (butts). The pit records is completed on Report of Scores, Small Arms Sheet 2, OpNav-3573-2 (latest revision). (See fig. 11-2.)

The chief pit officer, during a record practice, records the scores in ink or indelible pencil on the above form. This rough copy is known as the pit record and is kept by relays. Individual names are not recorded here, but relays and target numbers serve to identify the individuals later. Cards known as pit cards are completed one for each target for each string of shots. The pit officer collects these cards and transfers the information from each to his pit record.

Firing Line Records are also kept on Small Arms Sheet 2. (See fig. 11-2.) During record practices a rough copy of these reports is kept by the officer in charge of the firing lines in ink or indelible pencil. On this record, each shooter is recorded by relay and target number and, in addition, by name. The officer in charge of the firing lines records data on these records as it comes from the score boards in a prescribed manner. Scoreboards (usually blackboards) are portable and are placed at the firing line being used, one for each target. Scores on the firing line record are always checked against the pit records before any announcement is made concerning qualification of the shooter. Of course, these figures have to be checked also before a smooth copy of the firing line record is made. In order for the pit records to be correctly kept, it is necessary to keep the different relays firing in the same order until completion of firing.

SMALL ARMS REPORTS

Expenditure Report

As in the case of all other conventional ammunition expenditures, small arms expenditures are submitted quarterly or as deemed necessary by higher authority. The standardized form Fleet/Overseas/Conus Ammunition Assets and Expenditure Report SPCC 8015-15 is used, SPCC Inst. 8015.16 (Series) outlines exact procedures in submitting expenditure reports.

Loss Report

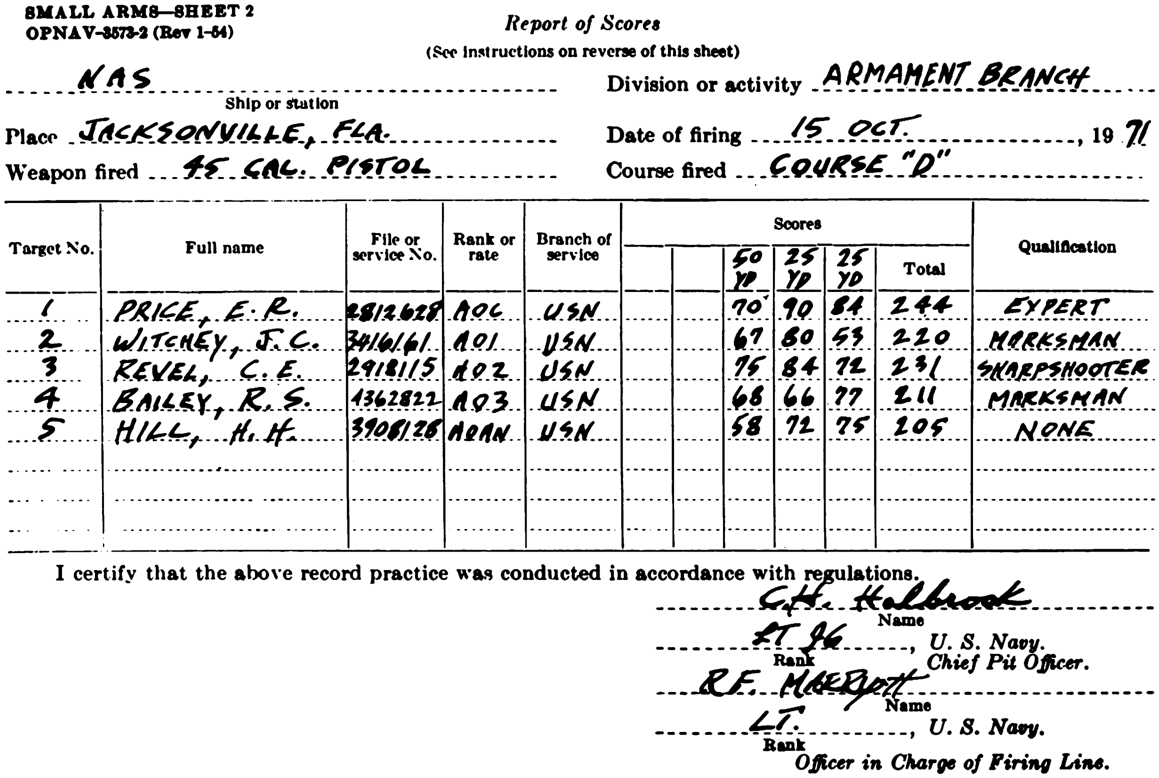
Whenever small arms have been lost or stolen the following authorities should be notified immediately:

1. Local police (civil, military, or naval).
2. District Intelligence Officer.
3. Federal Bureau of Investigation, National Stolen Property Files, via the Director of Naval Intelligence, Department of the Navy, Washington, D.C. 20305.

NOTE: In the case of loss overboard, above notification is not required. However, a survey procedure must be initiated.

REPORTS OF RIFLE AND PISTOL MATCHES

Reports of Rifle and Pistol Matches are made immediately upon completion of a Navy or fleet rifle and pistol competition. The original of this



SMALL ARMS—SHEET 2
OPNAV-3573-2 (Rev 1-64)

Report of Scores
(See instructions on reverse of this sheet)

NAS
Ship or station

Division or activity ARMAMENT BRANCH

Place JACKSONVILLE, FLA.

Date of firing 15 OCT., 19 71

Weapon fired 45 CAL. PISTOL

Course fired COURSE "D"

Target No.	Full name	File or service No.	Rank or rate	Branch of service	Scores						Qualification
							50 YD	25 YD	25 YD	Total	
1	PRICE, E. R.	2812628	AOC	USN			70	90	84	244	EXPERT
2	WITCHEY, J. C.	3416161	AO1	USN			67	80	53	220	MARKSMAN
3	REVEL, C. E.	2918115	AO2	USN			75	84	72	231	SHARPSHOOTER
4	BAILEY, R. S.	4362822	AO3	USN			68	66	77	211	MARKSMAN
5	HILL, H. H.	3908126	AOAN	USN			58	72	75	205	NONE

I certify that the above record practice was conducted in accordance with regulations.

C.H. Holbrook
Name
LT JG, *U. S. Navy.*
Rank
Chief Pit Officer.

R.F. MARRIOTT
Name
LT., *U. S. Navy.*
Rank
Officer in Charge of Firing Line.

AO.580

Figure 11-2.—Report of Scores, Small Arms, Sheet 2 (OpNav Form 3573-2).

letter report goes to the Chief of Naval Personnel and a copy to the Chief of Naval Operations. This report is made by the officer conducting the competition if the match is a Fleet or U.S. Navy rifle or pistol competition. Local command competition reports are forwarded by the command whose personnel and/or teams participated.

The report provides the date and place of each match; name, unit, or organization of winning team and the aggregate score; name, rank or rate and aggregate score of each team member of the winning and placing team in team matches, and the same for individual medal winner in individual matches; name, unit or station of other competing teams, their aggregate scores and standing in team matches; comments on the conduct of the competition, and items of interest regarding small arms training and team organization.

Entries in the enlisted Service Records concerning small arms firing are made by commanding officers upon receipt of Small Arms Sheet 2 (Report of Scores). Page 4 of the enlisted man's service record is used to record qualifications. On this page are sequentially entered all data concerning an individual's gunnery experiences. Small arms practices, qualifications, and awards are entered hereon. If the man fails to qualify after preparatory training in small arms, an entry to this effect must be made in his service record page 13 as this fact affects his eligibility to fire again for a preset time. All information concerning an officer's small arms qualifications is made by a memorandum for the record and forwarded to the Chief of Naval Personnel for inclusion in his file jacket.

Report of Scores

Report of scores is made on Small Arms Sheet 2. Immediately after each record practice, the officer in charge of the firing line completes this form and submits a copy to each commanding officer concerned with the practice. These records have to be certified by both the pit officer and the officer in charge of the firing line. The smooth copy of this report is compiled from data contained on the pit record and the firing line record. In case of disagreement between these two sources of information, the pit record will control.

Competitions and Medals

There are numerous competitions held throughout the services. Navy and Marine personnel are eligible to compete in matches in other than their own service under specified circumstances. Medals are awarded for successful qualification in several types of small arms firing.

All commanders are encouraged to conduct rifle and pistol competitions to the fullest extent that time, facilities, and ammunition allowances will permit. The major objectives of competitive firing are to extend the scope of regular small arms training, stimulate interest in small arms firing, and to select and develop both individuals and teams to represent the Navy in national and international competitions. A detailed listing of the various competitions, awards, medals, trophies, and qualification periods may be found in NavPer's 93863. Personnel associated with match competitions and qualification firings should become thoroughly familiar with that publication.

SAFETY PRECAUTIONS

No attempt will be made in this chapter to give in detail the many safety precautions associated with the correct handling, operation, field stripping, reassembling, and firing of each type of small arm used in the Navy. Pertinent instructions and safety precautions are published for each type of weapon and may be procured in quantity if desired. There are, however, certain basic precautions concerning small arms utilization and range procedures which should be stressed repeatedly at all small arms facilities, both on the range and in the classroom. These precautions should be conspicuously displayed at the range as well as in the classroom. They should become a matter of habit for personnel assigned to and undergoing training at the range.

The general safety precautions and regulations to be applied to the utilization of small arms are as follows:

1. Treat every weapon as a loaded weapon.
2. Never point a weapon at anyone you do not intend to shoot.
3. No weapon will be loaded except at the firing point.
4. During and after loading, the weapon will be kept pointed in the safest direction until aimed at the target for firing.
5. On leaving the firing line, open the breech and lock it open.
6. Never leave a loaded weapon or one with rounds in the magazine where it may be picked up by others.
7. Immediately upon picking up a weapon and pointing it in a safe direction, make sure by personal inspection that it is not loaded.
8. Do not turn around on the firing line at any time with a weapon in hand.
9. Do not consider a weapon unloaded and safe after having removed the magazine only. Always examine the breech for a round in the chamber after removing the magazine.
10. Ascertain that the bore and action of a weapon are not obstructed in any manner prior to loading and firing.
11. Never leave the firing line to mark targets until specifically told to do so by the range officer or petty officer.
12. Any and all misfires should be treated as hangfires. In no event should the breech be opened sooner than 10 seconds after the last attempt to fire the round is made.

13. Never become hurried when involved in handling and firing weapons. Strive to be relaxed but alert at all times.

14. Strict discipline with regard to distractions, such as loud talking and skylarking, will be observed throughout the range, and all personnel not actively engaged in some phase of range work or actually firing will be ordered to leave the premises.

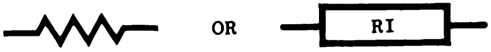
15. No live ammunition is to be removed from the firing line by a shooter, unless ordered to do so by the range officer or petty officer.

Although the Navy's small arms marksmanship training program has taken great strides in recent years, and the number of personnel who have qualified in the use of various small arms has increased greatly, the continued high rate of firearms accidents evokes a demand for a hard look at "Safety First." Clearly, the training implemented by qualified instructors is producing skilled marksmen, but this is not "good enough." Anyone who assigns a gun to another must see to it that with the gun goes the proper instruction for safe gun handling. Safe gun handling comes only with knowledge and experience. Senior AO's responsible for small arms marksmanship training must teach Navy men the safe handling of small arms as well as good marksmanship.

APPENDIX I

SYMBOLS

RESISTORS:



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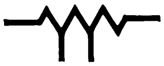

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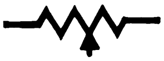
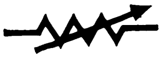
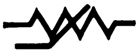


ADJUSTABLE
TAP

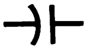


CONTINUOUSLY
VARIABLE



NONLINEAR

CAPACITORS:



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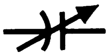
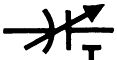
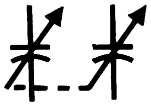


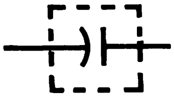
VARIABLE



TRIMMER



GANGED



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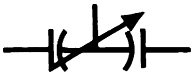

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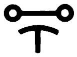
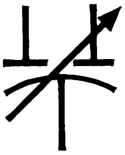
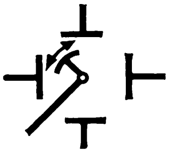


FEED-THROUGH



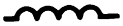
DIFFERENTIAL



PHASE SHIFT

(WHEN CAPACITOR ELECTRODE IDENTIFICATION IS NECESSARY, THE CURVED ELEMENT SHALL REPRESENT THE OUTSIDE ELECTRODE IN FIXED PAPER-DIELECTRIC AND CERAMIC-DIELECTRIC, THE NEGATIVE ELECTRODE IN ELECTROLYTIC CAPACITORS, THE MOVING ELEMENT IN VARIABLE AND ADJUSTABLE CAPACITORS, AND THE LOW POTENTIAL ELEMENT IN FEED-THROUGH CAPACITORS.)

INDUCTIVE COMPONENTS:



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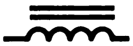
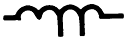


MAGNETIC
CORE



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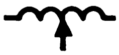
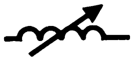
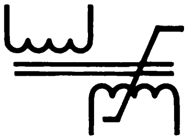


ADJUSTABLE

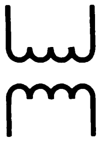


ADJUSTABLE OR
CONTINUOUSLY
ADJUSTABLE



SATURABLE
CORE REACTOR

TRANSFORMERS



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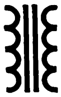
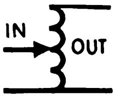


MAGNETIC CORE
TRANSFORMER



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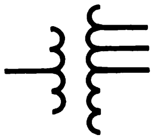
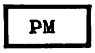


WITH TAPS,
SINGLE-PHASE

PERMANENT MAGNET



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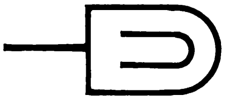

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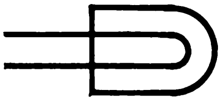
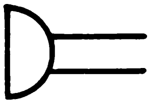


MICROPHONE



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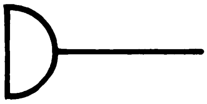

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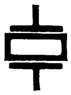
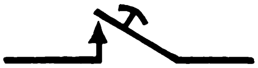


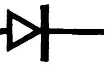
QUARTZ CRYSTAL;
PIEZOELECTRIC CRYSTAL
UNIT.

KEY:



RECTIFIER:

GENERAL



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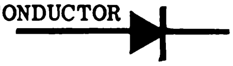
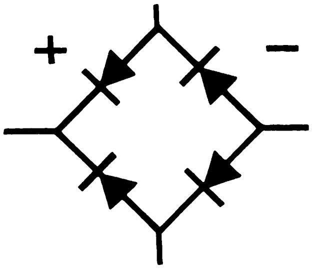
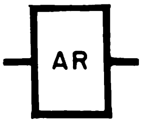


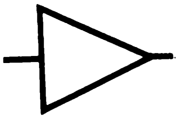
NORMAL CURRENT FLOW IS AGAINST THE ARROW



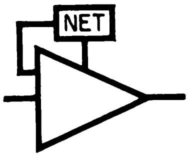
FULL WAVE BRIDGE TYPE

AMPLIFIER





TRIANGLE POINTS
IN DIRECTION OF
TRANSMISSION
(SIGNAL FLOW)



AMPLIFIER WITH
EXTERNAL
FEEDBACK PATH

BASIC SYMBOL INDICATES ANY METHOD OF AMPLIFICATION EXCEPT THAT OPERATING ON THE PRINCIPLE OF ROTATING MACHINERY.

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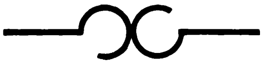

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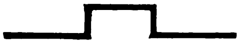
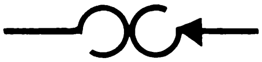


THERMAL RELAY WITH
NORMALLY CLOSED
CONTACT.



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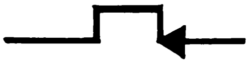
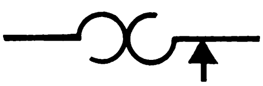


FLASHER; THERMAL CUTOUT



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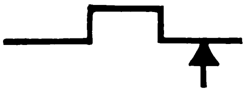

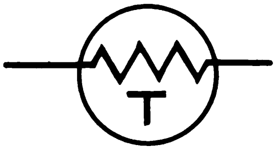

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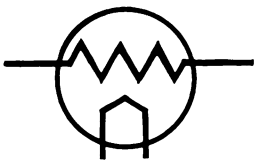
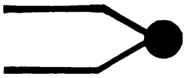
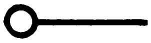


WITH INTEGRAL
HEATING ELEMENT



TEMPERATURE-MEASURING THERMOCOUPLE
(DISSIMILAR METAL DEVICE)

INPUTS (NONSTANDARD):



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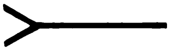
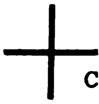
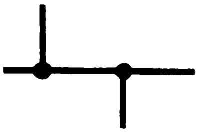


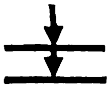
PATH, TRANSMISSION:



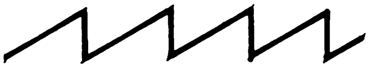
CROSSING NOT
CONNECTED



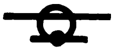
JUNCTION CONNECTED



TWISTED PAIR

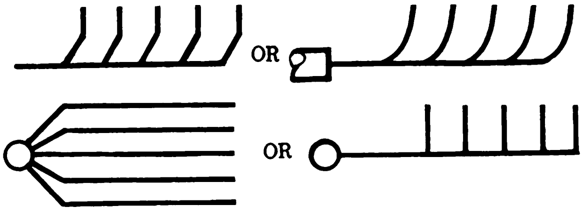


AIR OR SPACE PATH



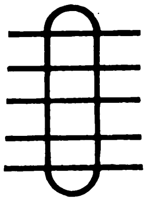
COAXIAL

GROUPING OF WIRES IN BUNDLES:

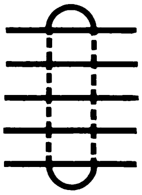


GROUPING OF WIRES IN CABLES:

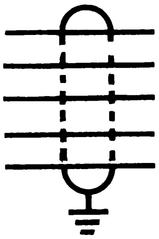
CABLES



FIVE-
CONDUCTOR
CABLE



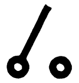
SHIELDED
FIVE-CONDUCTOR
CABLE



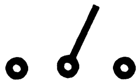
GROUNDED
SHIELD

NUMBER OF CONDUCTORS MAY BE ONE OR MORE AS NECESSARY

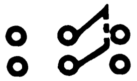
SWITCHES:



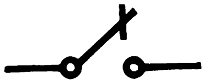
GENERAL
(SINGLE THROW)



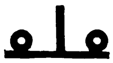
GENERAL
(DOUBLE THROW)



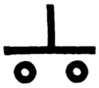
TWO POLE
DOUBLE THROW
SWITCH



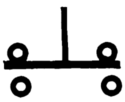
KNIFE SWITCH



PUSHBUTTON
(BREAK)

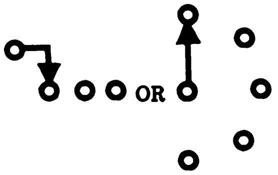


PUSHBUTTON
(MAKE)



PUSHBUTTON TWO CIRCUIT

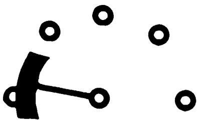
SELECTOR SWITCHES

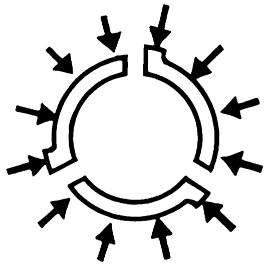


GENERAL

ANY NUMBER OF TRANSMISSION PATHS MAY BE SHOWN. ALSO BREAK BEFORE MAKE SWITCH.

MAKE BEFORE
BREAK

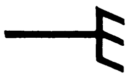




WAFER, TYPICAL 3-POLE, 3-CIRCUIT SWITCH. VIEWED FROM END OPPOSITE CONTROL KNOB. FOR MORE THAN ONE SECTION, #1 IS NEAREST CONTROL KNOB.

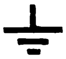
CIRCUIT RETURNS

CHASSIS CONNECTION



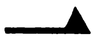
(THE CHASSIS OR FRAME IS NOT NECESSARILY AT GROUND POTENTIAL.)

GROUND

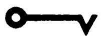


CONTACTS (ELECTRICAL):

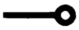
SWITCH



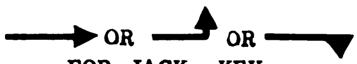
MOMENTARY
SWITCH



LOCKING



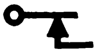
NONLOCKING



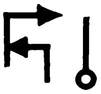
FOR JACK, KEY,
RELAY, ETC.

CONTACTS (ELECTRICAL): (Continued)

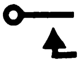
CONTACT ASSEMBLIES



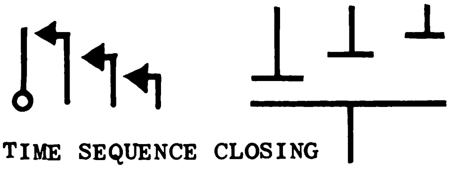
CLOSED CONTACT
(BREAK)



MAKE BEFORE
BREAK

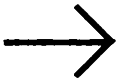


OPEN CONTACT
(MAKE)

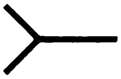


TIME SEQUENCE CLOSING

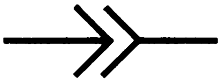
DISCONNECTING DEVICES:



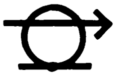
MALE
(PIN CONTACT)



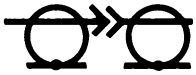
FEMALE
(SOCKET CONTACT)



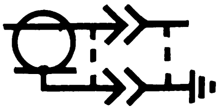
ENGAGED
(PIN-TO-SOCKET)



COAXIAL
(MALE)

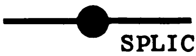


COAXIAL CONNECTORS
MATED

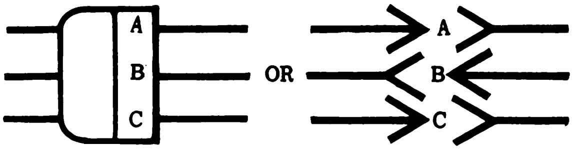


COAXIAL CONNECTED
TO SINGLE CONDUCTOR

THE CONNECTOR SYMBOL IS NOT AN ARROWHEAD. IT IS LARGER AND THE LINES ARE DRAWN AT A 90° ANGLE.



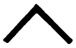
SPLICE



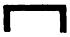
CONNECTOR ASSEMBLY (GENERAL)

ELECTRON TUBES:

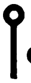
COMPONENT TUBE SYMBOLS



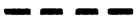
DIRECTLY-HEATED
(FILAMENTARY)
CATHODE



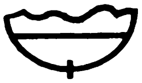
INDIRECTLY-HEATED
CATHODE



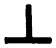
COLD
CATHODE



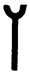
GRID



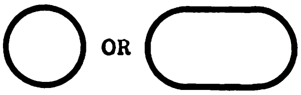
POOL CATHODE



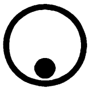
ANODE OR
PLATE



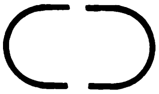
PHOTOCATHODE



ENVELOPE (SHELL)

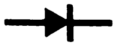


GAS FILLED
ENVELOPE

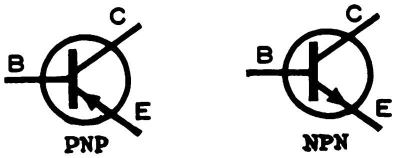


SPLIT ENVELOPE

SEMICONDUCTOR DEVICES:

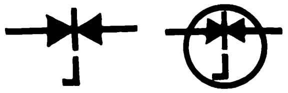


DIODE

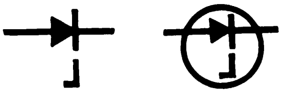


PNP NPN

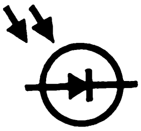
TRANSISTORS



BREAKDOWN DIODE,
BIDIRECTIONAL

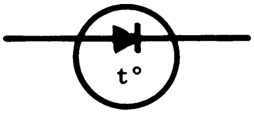


BREAKDOWN DIODE,
UNDIRECTIONAL
(ALSO BACKWARD DIODE)

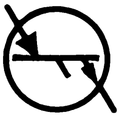


PHOTODIODE

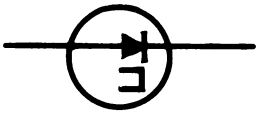
SEMICONDUCTOR DEVICES: (Continued)



TEMPERATURE DEPENDENT DIODE

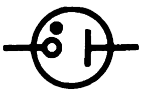


PNPN SWITCH

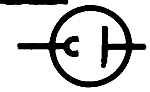


TUNNEL DIODE

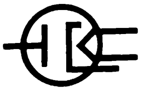
TYPICAL ELECTRON TUBES:



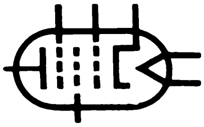
COLD CATHODE GAS TUBE



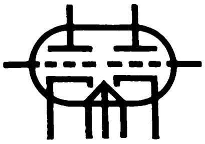
PHOTOTUBE SINGLE UNIT, VACUUM



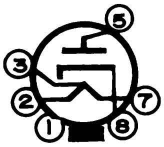
DIODE



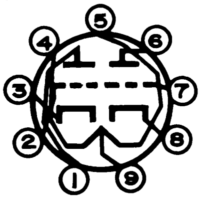
PENTODE



TWIN TRIODE ILLUSTRATING ELONGATED ENVELOPE

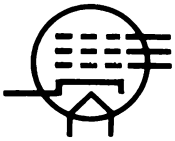


DIODE SHOWING BASE CONNECTIONS

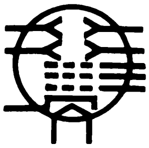


TWIN TRIODE WITH TAPPED HEATER

TYPICAL CATHODE RAY TUBES:

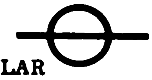


MAGNETIC DEFLECTION

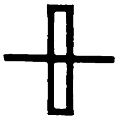


ELECTROSTATIC DEFLECTION

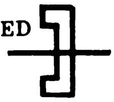
WAVEGUIDES:



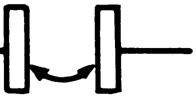
CIRCULAR



RECTANGULAR

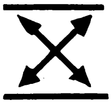


RIDGED

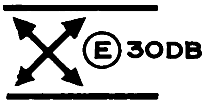


ROTARY JOINT

DIRECTIONAL COUPLERS



GENERAL

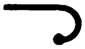


E PLANE APERTURE COUPLING, 30 DB TRANSMISSION LOSS

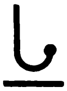
COUPLING METHODS:

GENERALLY USED FOR COAXIAL AND WAVEGUIDE TRANSMISSION.

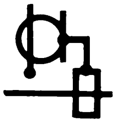
COUPLING BY APERTURE WITH AN OPENING OF LESS THAN FULL WAVEGUIDE SIZE. TYPE OF COUPLING WILL BE INDICATED WITHIN CIRCLE (E, H, OR HE).



COUPLING BY LOOP TO SPACE

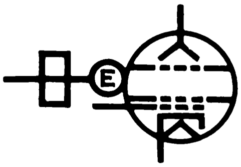


COUPLING BY LOOP TO GUIDED TRANSMISSION PATH

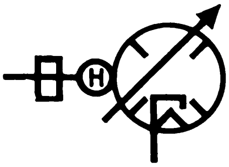


COUPLING BY PROBE FROM COAXIAL TO RECTANGULAR WAVEGUIDE WITH DIRECT-CURRENT GROUNDS CONNECTED

TYPICAL MAGNETRONS AND KLYSTRONS:

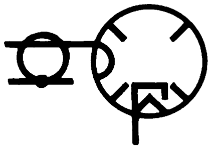


REFLEX KLYSTRON, APERTURE COUPLED

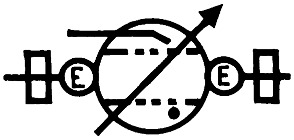


TUNABLE MAGNETRON, APERTURE COUPLED

TYPICAL MAGNETRONS AND KLYSTRONS: (Continued)

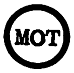


RESONANT TYPE WITH COAXIAL OUTPUT

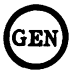


TRANSMIT-RECEIVE (TR) TUBE GAS FILLED, TUNABLE INTEGRAL CAVITY, APERTURE COUPLED, WITH STARTER

ROTATING MACHINES:

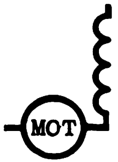


MOTOR

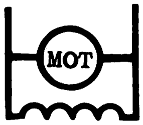


GENERATOR

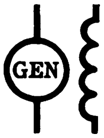
TYPES OF WINDINGS



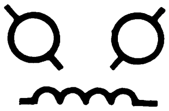
SERIES



SHUNT

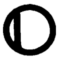


SEPARATELY EXCITED

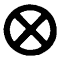


DYNAMOTOR

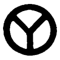
WINDING SYMBOLS



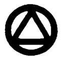
SINGLE-PHASE



TWO - PHASE



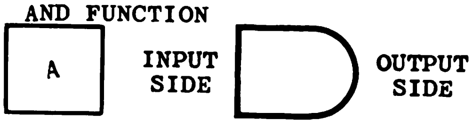
THREE-PHASE (WYE)



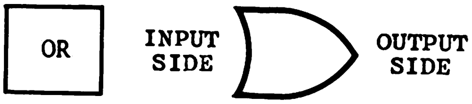
THREE-PHASE (DELTA)

LOGIC FUNCTIONS:

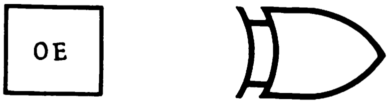
AND FUNCTION



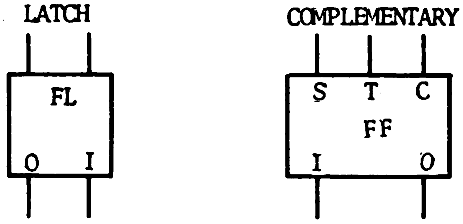
INCLUSIVE OR FUNCTION



EXCLUSIVE OR FUNCTION



FLIP-FLOPS

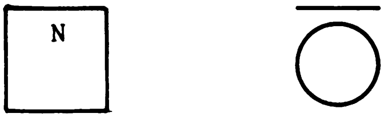


S-SET T-TRIGGER C-CLEAR

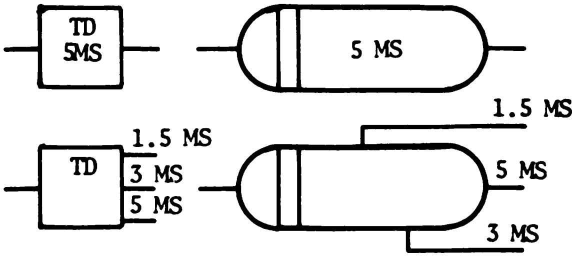
NEGATION

O

ELECTRIC INVERTER

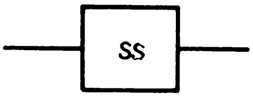


TIME DELAY

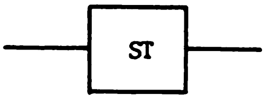


LOGIC FUNCTIONS: (Continued)

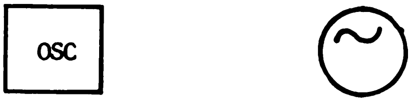
SINGLE SHOT



SCHMITT TRIGGER

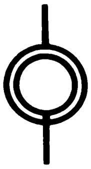


OSCILLATOR



SYNCHROS:

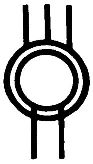
GENERAL



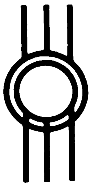
A LETTER COMBINATION FROM THE FOLLOWING LIST MAY BE PLACED ADJACENT TO THE SYMBOL TO INDICATE THE TYPE OF SYNCHRO:

TX - TORQUE TRANSMITTER
TDX - TORQUE DIFFERENTIAL TRANSMITTER
CX - CONTROL TRANSMITTER
CDX - CONTROL DIFFERENTIAL TRANSMITTER
TR - TORQUE RECEIVER
CT - CONTROL TRANSFORMER

SYNCHROS: (Continued)

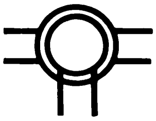


TRANSMITTER, RECEIVER, OR CONTROL TRANSFORMER

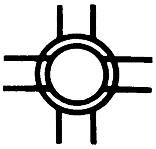


DIFFERENTIAL TRANSMITTER OR RECEIVER

RESOLVER (SYNCHRO)

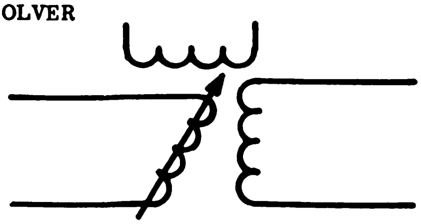


SINGLY-WOUND ROTOR

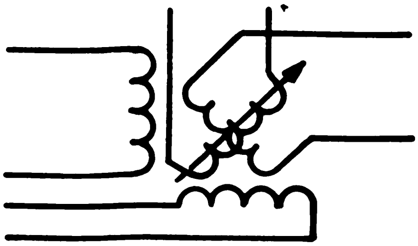


DOUBLY-WOUND ROTOR

RESOLVER

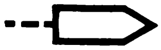


SINGLY-WOUND ROTOR

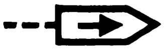


DOUBLY-WOUND ROTOR

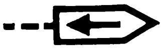
PICKUP HEADS:



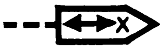
GENERAL



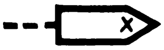
WRITING; RECORDING; HEAD,
SOUND RECORDER



READING; PLAYBACK; HEAD,
SOUND REPRODUCER

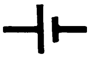


APPLICATION: WRITING, READING,
AND ERASING

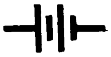


ERASING; ERASER, MAGNETIC

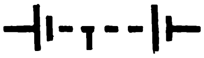
BATTERIES:



ONE CELL



MULTICELL

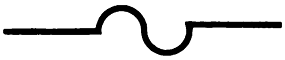


TAPPED MULTICELL

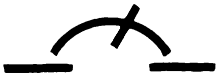
(LONG LINE IS ALWAYS POSITIVE)

CIRCUIT PROTECTORS

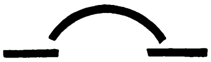
FUSE



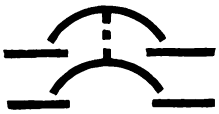
CIRCUIT BREAKERS



SWITCH

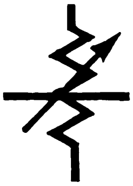


PUSH PULL OR PUSH

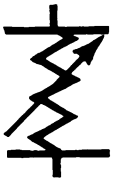


GANGED

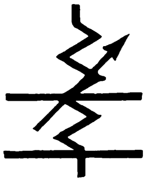
ATTENUATORS



GENERAL



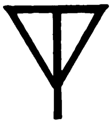
BALANCED



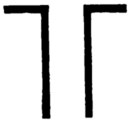
UNBALANCED

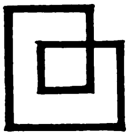
ANTENNAS

GENERAL

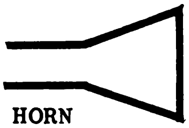


DIPOLE



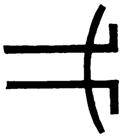


LOOP



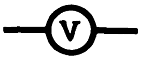
HORN

PARABOLIC



(NONSTANDARD)

METERS



A - AMMETER

CRO - OSCILLOSCOPE

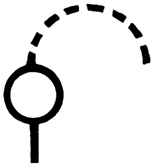
G - GALVANOMETER

MA - MILLIAMMETER

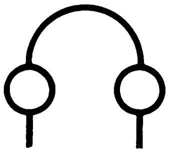
OHM - OHMMETER

V - VOLTMETER

HEADSET:



OR



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